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NATIONAL DAM SAFETY PROGRAM. DAM C-23 (MO 10283, MISSOURI - KAN--ETC(U)
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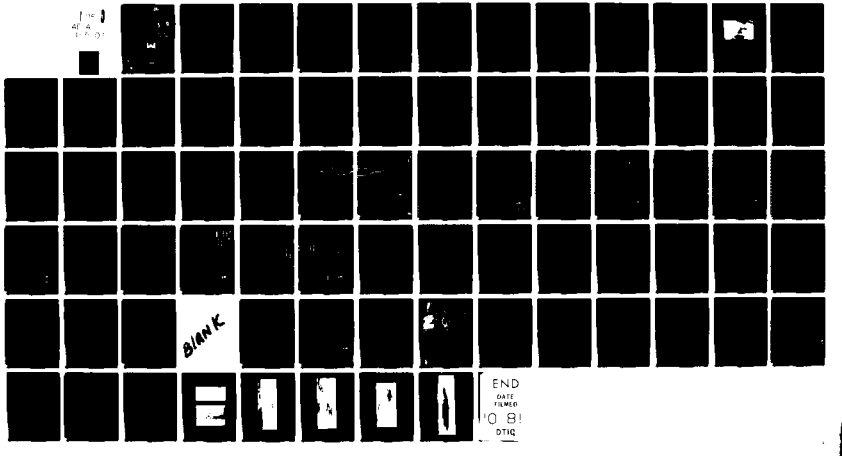

LEVEL II

1

MISSOURI - KANSAS CITY BASIN

DAM C-23

LAFAYETTE COUNTY, MISSOURI

MO 10283

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Dam C-23 (MO 10283, Missouri - Kansas City Basin, Lafayette County, Missouri. Phase I Inspection Report.

(9) Final rept.,

(15) DACW43-78-C-0166

(10) John M. /Healy Steven L. /Brady

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Dam C-23 (MO 10283) Lafayette County, Missouri	5. TYPE OF REPORT & PERIOD COVERED Final Report 6. PERFORMING ORG. REPORT NUMBER
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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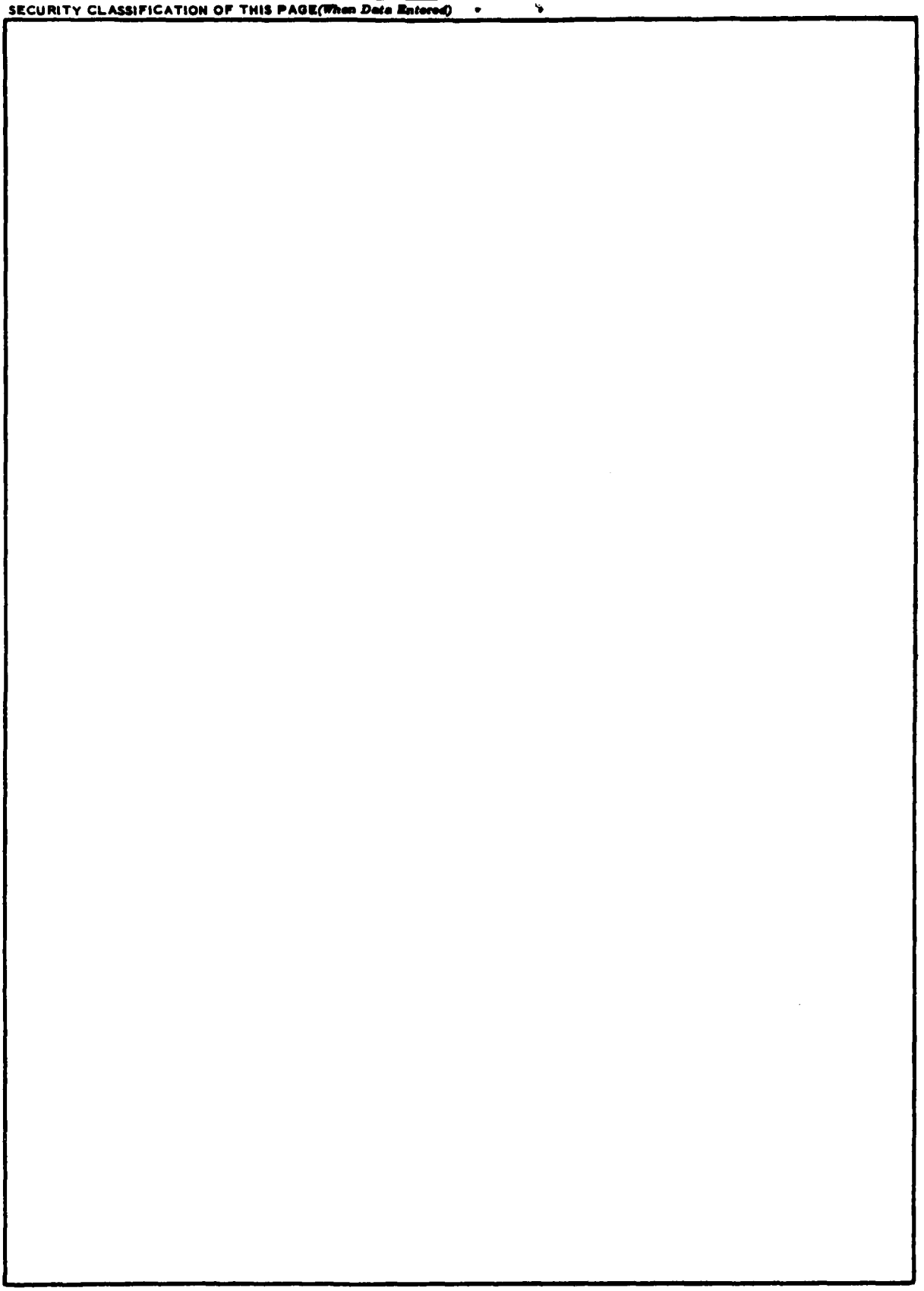

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Dam C-23 Phase I Inspection Report

This report presents the results of field inspection and evaluation of Dam C-23. It was prepared under the National Program of Inspection of Non-Federal Dams.

SIGNED 26 ..79

SUBMITTED BY: _____ _____
Chief, Engineering Division Date

SIGNED 26 ..79

APPROVED BY: _____ _____
Colonel, CE, District Engineer Date

DAM C-23
LAFAYETTE COUNTY, MISSOURI
MISSOURI INVENTORY NO. 10283

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

For

The Governor of Missouri

December, 1978

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: Dam C-23

State Located: Missouri

County Located: Lafayette County

Stream: Unnamed Tributary to Missouri River

Date of Inspection: 2 August 1978

Dam C-23 was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, this dam has been classified by the St. Louis District Corps of Engineers as an intermediate size dam with a high downstream hazard potential. Their estimate of the damage zone extends 4 miles downstream of the dam. Lafayette County Dam C-22 is about 1/2 mile downstream of Dam C-23. If Dam C-23 should fail, then Dam C-22 also would likely fail. Within the damage zone are three houses, (two of which have associated farm buildings), one unimproved road crossing, one railroad bridge and one U.S. Highway Bridge.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 54 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam

of intermediate size with a high downstream hazard potential pass 100 percent of the PMF. The combined spillways will pass the 100-year flood, without overtopping.

The embankment and appurtenances are generally in good condition. Minor deficiencies, including erosion, tree growth and animal burrows, were noted and should be corrected by the owner. It was noted that the lake has never filled and suggestions were made for further investigation of under-seepage potential and possible associated dangers in this regard. Another deficiency was the lack of seepage analysis data. A detailed report is attached to be submitted to the owners and to the Governor of Missouri.

John M. Healy

John M. Healy, P.E.
Hanson Engineers, Inc.

Steven L. Brady, P.E.
Anderson Engineering, Inc.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
DAM C-23 - ID NO. 10283

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APPENDICES

Aerial View of Lake and Dam

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of Dam C-23 in Lafayette County, Missouri be made.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines For Safety Inspection of Dams." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Dam C-23 is an earth fill structure approximately 50 ft high and 500 ft long at the crest. The appurtenant works consist of a concrete drop inlet and reinforced concrete pipe primary spillway, which is located near the center of the dam, and a grass covered emergency spillway, which is located at the north abutment. Sheet 3 of Appendix A shows a plan of the embankment and spillways and a typical section of the embankment.

B. Location:

The dam is located in the northwest part of Lafayette County, Missouri on a small tributary of the Missouri River. The dam and lake are within the Bates City, Missouri quadrangle sheet, 1 1/2 miles west and 1/2 mile south

of Wellington (SW 1/4 Section 20, Twp. 15 N, R 28 W-latitude 39° 7.4'; longitude 94° 1.4'). Sheet 1 of Appendix A shows the general vicinity and location of the dam. Sheet 2 shows a plan of the immediate area of the dam and lake.

C. Size Classification:

With an embankment height of 50 ft and a maximum storage capacity of approximately 232 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. Their estimate of the damage zone extends 4 miles downstream of the dam. Lafayette County Dam C-22 is about 1/2 mile downstream of Dam C-23. If Dam C-23 should fail, then Dam C-22 would likely fail. Also within the damage zone are three houses (two of which have associated farm buildings), one unimproved road crossing, one railroad bridge and one U.S. Highway Bridge.

E. Ownership:

The dam was designed by the Soil Conservation Service (SCS) but the property upon which the dam and lake are located is retained by the property owner or owners. These owners granted an easement to the Wellington-Napolean Watershed Subdistrict to construct, operate, and maintain this structure. The subdistrict is the owner and is responsible for the structure. The address of the subdistrict is 120 West 19th Street, Higginsville, Missouri 64037. The As-Built plans indicate the primary owners to be Omer and Erna Borgman. The tenant who provided access to the dam is Mr. Bohall.

F. Purpose of Dam:

The purpose of the PL-566 watershed program is to provide watershed protection and flood prevention. The purpose of these structures is for grade stabilization with flood water retarding features. These lakes may be stocked with fish but not by the Soil Conservation Service. They may be stocked with fish from the Federal and State Fisheries in cooperation with individual landowners.

G. Design and Construction History:

The dam was designed by the Soil Conservation Service and constructed under their inspection supervision (inspection handled by the Higginsville District Office). The dam was completed in 1970. As-Built plans are available and have been used to prepare this report. No significant problems in regards to seepage through or stability of the embankment are reported to have occurred since the dam was built. According to SCS district pesonnel, no modifications have been made to the dam.

H. Normal Operating Procedure:

Normal flows will be passed by an uncontrolled drop inlet spillway, whereas a grassed emergency spillway would come into operation for major floods. Local SCS personnel have indicated that the lake has never filled so that neither the primary spillway nor the emergency spillway have been in service (see Section 7.2.A of this report).

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A is a plan of the embankment and spillways with a typical cross section of the dam. Sheet 4 presents a plan and profile of the primary spillway. Sheet 5 presents a profile and cross section of the foundation drainage system.

A. Drainage Area:

The drainage area for this dam, as obtained from the Bates City, Missouri and Camden, Missouri 7.5 minutes quad sheets, is equal to approximately 146 acres.

B. Elevations (Feet Above M.S.L.):

(1) Top of dam (measured): north end 783.2; center 783.8; south end 782.8.
Top of Dam (As-Built Plans): north end 782.7; center 784.5; south end 782.5.

(2) Principal Spillway Crest: As-Built Plans 777.0; measured 776.3.

(3) Emergency Spillway Crest: As-Built Plans 779.5; measured 779.6.

(4) Primary Spillway Outlet Pipe Invert: As-Built Plans 740.0; measured 739.9.

(5) Maximum Design Pool (As Built Plans): 781.7.

(6) Pool on Date of Inspection: measured 761.7.

(7) Apparent High Water Mark on Date of Inspection: measured 766.0.

(8) Streambed at Downstream Toe of Dam: As-Built Plans 736.5; measured 736.6.

(9) Maximum Tailwater: Unknown.

C. Discharge at Dam Site:

(1) All discharge at the dam site is through uncontrolled spillways.

(2) Estimated Discharge Capacity at Top of Dam (El. 782.8): 327 cfs.

D. Reservoir Surface Areas:

(1) At Principal Spillway Crest: As Built Plans 11.8 acres.

(2) At Top of Dam (El. 782.8): 17 acres. Extrapolated from table on As-Built Plans (see Sheet 10 of Appendix B).

E. Storage Capacities:

(1) At Principal Spillway Crest: 148 acre-ft.

(2) At Top of Dam (El. 782.8): 232 acre-ft. (See Sheet 7 of Appendix C.)

F. Reservoir Lengths:

(1) At Principal Spillway Crest (Estimated from As-Built Plans): 1750 ft.

(2) At Top of Dam (Estimated from As-Built Plans): 1900 ft.

G. Dam:

(1) Type: rolled earth.

(2) Length at Crest: 500 ft.

(3) Height: 50 ft.

(4) Top Width: 14 ft.

(5) Side Slopes: 2.5 H: 1 V.

(6) Zoning: homogeneous silts and clays.

(7) Cutoff: shallow core trench.

H. Principal Spillway:

(1) Location: center of dam--Station 3+65.

(2) Type: 2 ft by 6 ft drop inlet concrete structure (crest El. 776.3; 12 ft in length) with a 24 in. diameter reinforced concrete outlet pipe through the dam. The outlet pipe is 184 ft long and is supported on a type A3 cradle, with 4 concrete antiseep collars. The pipe inlet invert is at El. 751.0 and the outlet invert is at El. 740.0 (see Sheet 4 of Appendix A). No stilling basin is provided at the end of the primary spillway outlet pipe; a plunge pool is expected to be created.

I. Emergency Spillway:

(1) Location: north abutment.

(2) Type: grass covered earth with 20 ft crest length and 3 H: 1 V side slopes.

SECTION 2 - ENGINEERING DATA

2.1 GENERAL:

Available design computations and reports for Dam C-23 include a geology and soils report which contains soils testing information for the foundation and borrow materials (includes soil classifications, grain size analyses, shear strength tests, consolidation tests and permeability tests). Based on this information, design recommendations were made regarding site preparation, foundation drainage and embankment configurations. The As-Built plans contain a summary of the hydrologic and hydraulic design data used for the primary and emergency spillways. No documentation of construction inspection records have been obtained. There are no documented maintenance and operation data to our knowledge.

2.2 DESIGN:

A. Surveys:

The As-Built drawings show the topography of the immediate dam site area (Sheets 2 and 3 of Appendix A). A bench mark in the form of a brass cap in a concrete monument is located in a fence corner on the emergency spillway end of the dam, approximately 50 ft north of the west gate (BM C-23 elevation = 764.75).

B. Geology and Subsurface Materials:

Physiographically, the site is located in the Missouri River loess hills area, which is characterized by gently rolling topography. The subsurface materials in upland areas generally consist of in excess of 20 ft of loess underlain by a Kansan Age glacial till material. Geological maps of the area indicate that the bedrock is the Marmaton group of the upper Desmoinesian series of the Pennsylvanian system. The Marmaton group consists of a sucession of shale, limestone, clay and coal beds.

A publication entitled "Evaluation of Missouri's Coal Resources" by the Missouri Geological Survey indicates that the "Lexington Coal Bed" was mined extensively in this area. The maps associated with this publication indicate that the dam site lies near the southern boundary of the undermining activity and that the coal seam mined was approximately 20 in. thick in the area. The U.S.G.S. quad sheet for the area (Camden, Missouri, 1950) indicates an inactive mine shaft

approximately 1 1/2 miles northeast of the dam (see Sheet 1 of Appendix C). The Coal Resources publication previously mentioned indicates that the depth to the coal seam at that location is approximately 32 ft and that the thickness of the seam is 18 in. If the coal seam is horizontal, then it would be at a depth of approximately 70 ft below the stream bed at the center of the dam (coal seam at elevation 660 to 665).

A boring plan and description of the soils encountered in the borings (Sheets 15 and 16 of the As-Built plans) are presented as Sheets 1 and 2 of Appendix B. Sheets 3, 4 and 5 of Appendix B present a description of the surface geology and physiography, and interpretations and conclusions regarding the soils encountered in the boring program (from geology and soils report by SCS). The soils encountered in the borings are generally low plasticity clays and silts to a depth of approximately 30 ft below the ground surface. Dry density determinations on "core" samples were between 1.2 g/cc (74.9 pcf) and 1.5 per g/cc (93.6 pcf) and estimated "blow counts" were between 5 and 10. A sand material was encountered at a depth of approximately 30 ft in Borings 3, 301 and 302 (top of sand layer at elevation 710 to 730). The maximum penetration of the borings was to approximate elevation 700. "Refusal" was encountered in borings for Dam A-21 (adjacent watershed) at elevation 675 to 680 (possible elevation of bedrock in the area).

C. Foundation and Embankment Design:

Reference should be made to Sheets 6 through 9 of Appendix B which contain a summary of the soil test data and recommendations for the foundation and embankment design (from geology and soils report by SCS). Because of the existance of sand layers and the possibility of boils occurring in the plunge pool area, a foundation drainage system was developed (includes a drainage trench and two vertical drains penetrating to elevation 708). The foundation drainage system is shown on Sheets 4 and 5 of Appendix A (from As-Built Plans). A shallow core trench apparently was constructed at the base of the dam along its entire length.

Borrow material for the dam was obtained from the reservoir area upstream of the embankment. Stability analyses based on the use of this material were performed by SCS. It was recommended that the embankment materials be

compacted to 95 percent of the maximum dry density as obtained by the Standard Proctor Compaction Test and at a moisture content wet of optimum. There is apparently no particular zoning of the embankment, and no internal drainage features (except for the previously described foundation drainage system) are known to exist. No construction inspection test results have been obtained.

D. Hydrology and Hydraulics:

Design data, storage curves and routing curves for the "emergency spillway" and "freeboard" hydrographs are presented on Sheets 10 through 12 of Appendix B (from As-Built plans by SCS). Based on this data, a field check of spillway dimensions and embankment elevations, and a check of the drainage area on U.S.G.S. quad sheets, a hydrologic analysis using U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 7. It was concluded that the primary and emergency spillways combined will pass 54 percent of the Probable Maximum Flood.

E. Structure:

Structural design computations for apurtenant structures were not obtained. Details of all concrete structural elements (riser structure, etc.) are shown on the As-Built plans.

2.3 CONSTRUCTION:

No construction inspection data has been obtained. Construction supervision was accomplished by the Soil Conservation Service district local office in Higginsville, Missouri.

2.4 OPERATION AND MAINTENANCE:

On this structure, there is an operation and maintenance agreement between the Soil Conservation Service and the Wellington-Napolean Watershed Subdistrict. The operation and maintenance agreement spells out the operation and maintenance requirements and the inspection procedures. Regional SCS office personnel indicated that a yearly questionnaire is sent to land owners inquiring as to maintenance problems. It was reported that inspection stops are made on an irregular basis by SCS district personnel (Higginsville office).

2.5 EVALUATION:

The available engineering data did include slope stability analyses but no seepage analyses, although seepage analyses apparently have been performed (see discussion of uplift on Sheet 7 of Appendix B). The owner should locate these analyses or have an engineer experienced in the design of dams perform detailed seepage analyses.

The engineering data available were inadequate to make a detailed assessment of the design and particularly the construction of the dam. No valid engineering data on the construction of the dam were found.

SECTION 3 - VISUAL INSPECTION

3.1 GENERAL:

The field inspection was made on 2 August 1978. The inspection team consisted of personnel from Anderson Engineers, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Mike Gray -Anderson Engineers
(Instrument Man)

Steve Brady - Anderson Engineers
(Civil Engineer)

Jack Healy - Hanson Engineers
(Geotechnical and Structural Engineer)

Gene Wertepny - Hanson Engineers
(Hydraulics Engineer)

Dave Daniels - Hanson Engineers
(Geotechnical and Hydraulics Engineer)

3.2 DAM:

The dam is an earth fill embankment constructed from borrow obtained from the emergency spillway area and the reservoir area below normal pool. Based on the soil borings, the fill material would be expected to consist of low plasticity clays and silts.

The embankment is grass covered and appears to good condition. A few one to two year old trees (willows and cottonwoods) were growing on the front face of the dam between elevations 762 and 766. No sloughing of the embankment or seepage through or under the embankment was evident. The foundation drain outlet was dry. There was some slight erosion at the downstream embankment-abutment contacts (more pronounced on the south abutment). Also, there was some slight erosion on the upstream face of the dam below the primary spillway crest. An animal burrow (shallow hole ± 3 ft deep) was noted on the outside edge of the downstream berm 60 ft from the south abutment.

The horizontal alignment appeared as constructed. No surface cracking or unusual movement was obvious. It should be noted, however, that elevations of the primary spillway crest and the center of the dam which were obtained in the field were approximately 0.5 ft lower than as indicated on the As-Built Plans (see Section 1.3.B of this report). All other elevations obtained in the field agreed fairly well with those indicated on the As-Built Plans. The descrepancy at the center of the dam might be explained by the possibility of some post construction settlement of the center portion of the dam.

No instrumentation (monuments, piezometers, etc.) were observed.

A. Primary Spillway and Outlet:

The riser structure was in good condition--no cracking or spalling of concrete was noted. The intake structure was surrounded by heavy grass.

The outlet pipe of the primary spillway was also in good condition. There was a very small flow dripping from the outlet pipe which could indicate some possible joint leakage. As mentioned previously the pool level was well below the crest of the primary spillway. Joint leakage could be associated with the possible embankment settlement discussed above. There is no energy dissipator at the end of the outlet pipe; a plunge pool is expected to be created for this purpose.

The channel downstream of the outlet pipe was grass and weed covered for the first 50 ft. Beyond 50 ft, the channel was lined with trees and brush. No plunge pool has been formed indicating that the primary spillway has probably never been used. The downstream channel empties into a lower lake approximately 500 ft downstream of the outlet pipe. There is a small check dam in the outlet channel at the upstream edge of the lower lake. Water in the outlet channel was not flowing and was stagnant. No significant erosion or sloughing of outlet channel slopes was noted.

Along the last portion of the primary spillway outlet pipe, there is a 6 in. diameter asbestos cement (pressure) pipe, class 100, which is the outlet of the foundation drainage system. The pipe has a length of 90 ft and a slope of 0.010. It is shown in the photographs on Sheet 1, 2 and 4 of Appendix D and in Sheets 4 and 5 of Appendix A.

B. Emergency Spillway:

The emergency spillway is in good condition. It measures 20 ft in width with 3 H: 1 V side slopes. The base and side slopes of the emergency spillway are grass covered. No erosion was noted and it appears that the emergency spillway has never been used.

3.3 RESERVOIR AND WATERSHED:

The immediate periphery of the lake was grass covered with moderate slopes. No sloughing or serious erosion of reservoir banks were noted.

The lake has apparently never filled. The apparent high water mark is at elevation 766, which is 11 ft below the primary spillway crest (primary spillway crest at elevation 777.0).

3.4 EVALUATION:

Small tree growths noted on the front face of the dam should be removed and all future growth should be removed on a yearly basis. Grass should be cut around the primary spillway crest. Excessive growths in this area could cause entrance restrictions. Visually observed erosional areas and animal burrows are deficiencies which, if left uncontrolled or uncorrected, could lead to serious problems in the future. These deficiencies should be able to be corrected by normally scheduled routine maintenance.

Photographs of the dam, appurtenant structures, and the reservoir and watershed are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam; therefore, no regulating procedures exist. The pool is controlled by rainfall, runoff, evaporation and the capacities of the uncontrolled spillways.

4.2 MAINTENANCE OF DAM:

Maintenance in terms of tree and brush removal and mowing of the grass is apparently the responsibility of the land owner. A yearly questionnaire is sent to land owners inquring as to maintenance problems. Inspection stops are reported to be made on an irregular basis by SCS regional personnel.

4.3 MAINTENANCE OF OPERATING FACILITIES:

No operating facilities exist at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM AND AFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Tree and brush growth should be removed from the dam on a yearly basis. Animal burrows or other holes in the dam should be filled. Erosional areas at abutment-dam contacts should be repaired. The use of riprap to prevent future erosion in these areas is a possibility.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design and Experience Data:

Design data used by the Soil Conservation Service to design this dam are shown on the As-Built plans and presented as Sheets 10 through 12 of Appendix B of this report. Based on this information, a field check of spillway dimensions and embankment elevations, and a check of the pool and drainage areas from U.S.G.S. quad sheets (Bates City Missouri and Camden, Missouri quad sheets), a hydrologic analysis using U.S. Army Corps of Engineers guidelines was performed and appears in Appendix C, Sheets 1 to 7.

B. Visual Observations:

The riser structure and outlet pipe for the primary spillway appear in good condition. A small flow from the outlet pipe (lake level below spillway crest) indicates the possibility of some pipe joint leakage. The earth and grass covered emergency spillway is in good condition. Neither the primary nor the emergency spillway have apparently ever been used.

No facilities are available to draw down the pool. The primary spillway is located near the center of the dam and the emergency spillway is located on the north abutment. Spillway releases would not be expected to endanger the integrity of the dam.

C. Overtopping Potential:

Based on the hydrologic and hydraulic analysis as presented in Appendix C, the combined primary and emergency spillways will not pass the Probable Maximum Flood without overtopping. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meterologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping. The routing of the PMF through the spillways and Dam, indicated that the Dam will be overtopped by 1.17 ft at reservoir elevation 783.97. The duration of the overtopping will be 3.17 hrs. and the maximum outflow 2522 cfs. Fifty percent of the PMF

was also routed through the spillways, resulting in a maximum reservoir elevation of 782.68, 0.12 ft below the lowest elevation of the dam (782.8). The peak outflow was 319 cfs. The portion of the PMF that will just reach the top of the dam is about 54 percent. The spillway system will be able to pass the 100 year frequency flood without overtopping.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

No serious deficiencies which would affect the structural stability of this dam were noted during the field inspection. However, if left unchecked, tree growth, animal burrows and the erosion at abutment-dam contact areas could cause stability problems in the future. The possibility of some joint leakage in the primary spillway outlet pipe should be periodically checked and investigated if it increases.

B. Design and Construction Data:

Stability analyses were performed by the Soil Conservation Service and recommendations were made regarding side slopes, berm widths and compaction densities (see Sheets 6 through 9 of Appendix B). Our site inspection indicated that the side slopes and berm widths were as recommended. If the embankment was placed in relatively thin lifts at the recommended density of 95 percent of the Standard Proctor maximum dry density (no laboratory testing records available to verify this), then the embankment should remain stable. A seepage analysis comparable to the requirements of the guidelines was not available which is considered a deficiency and should be corrected.

C. Operating Records:

No appurtenant structures requiring operation exist at this dam.

D. Post-Construction Changes:

To our knowledge, no post-construction changes have been made.

E. Seismic Stability:

Considering the seismic zone (1) in which this dam is located, an earthquake of this magnitude is not expected to cause a structural failure to this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

A. General:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

B. Safety:

The embankment itself is generally in good condition. A seepage analysis comparable to the requirements of the guidelines was not available, which is considered a deficiency and should be corrected. The possibility of some joint leakage in the primary spillway outlet pipe should be investigated. Also, the minor items which have been noted previously such as tree growth, animal burrows and abutment-dam contact erosion areas can and should be corrected and controlled.

The dam will be overtopped by flows in excess of 54 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

C. Adequacy of Information:

The conclusions in this report were based on review of the As-Built plans, the geologic and soil mechanics report prepared by the Soil Conservation Service, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein.

D. Urgency:

The remedial measures recommended in paragraph 7.3 should be accomplished in the near future. If the minor deficiencies listed in paragraph B are not corrected and if good maintenance is not provided, the embankment condition will continue to deteriorate and it could become serious in the future.

E. Necessity for Phase II:

Based on the results of the Phase I inspection, no Phase II inspection is recommended.

F. Seismic Stability:

This dam is located in Seismic Zone 1. An earthquake of this magnitude is not expected to be hazardous to this dam.

7.2 FURTHER INVESTIGATIONS:

A. Reservoir:

As mentioned previously this lake has never filled. Conversations with the state geologist have indicated that at least one lake in the area has apparently been leaking through abandoned mine shafts. However, the land owner and a former mine operator in the area have indicated that they do not believe that lake C-23 is undermined. Thus, the fact that the lake has never filled is probably not due to leakage through abandoned mine shafts.

It is also possible that leakage could be occurring through the underlying sand lenses encountered in the borings. No seapage was noted in the area immediately downstream of the dam. However, deeper substratum leakage into adjacent watersheds or lakes is a possibility, although somewhat remote due to the long distances involved. It should be noted in this regard that the pool elevation of lake C-23 was essentially the same as the pool elevation of lake A-21 (in an adjacent watershed--was inspected the following day). It is suggested that the possibility of leakage through sand layers be investigated further.

B. Outlet Pipe:

A very small amount of water was exiting from the outlet pipe on the day of the inspection. The source of the water could not be explained since the spillway was not flowing. The possibility of some joint leakage is suggested. Although apparently not serious at this time, this condition should be evaluated by local maintenance personnel.

7.3 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended and should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

(1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

(2) A seepage analysis comparable to the requirements of the guidelines was not available, which is considered a deficiency and should be corrected.

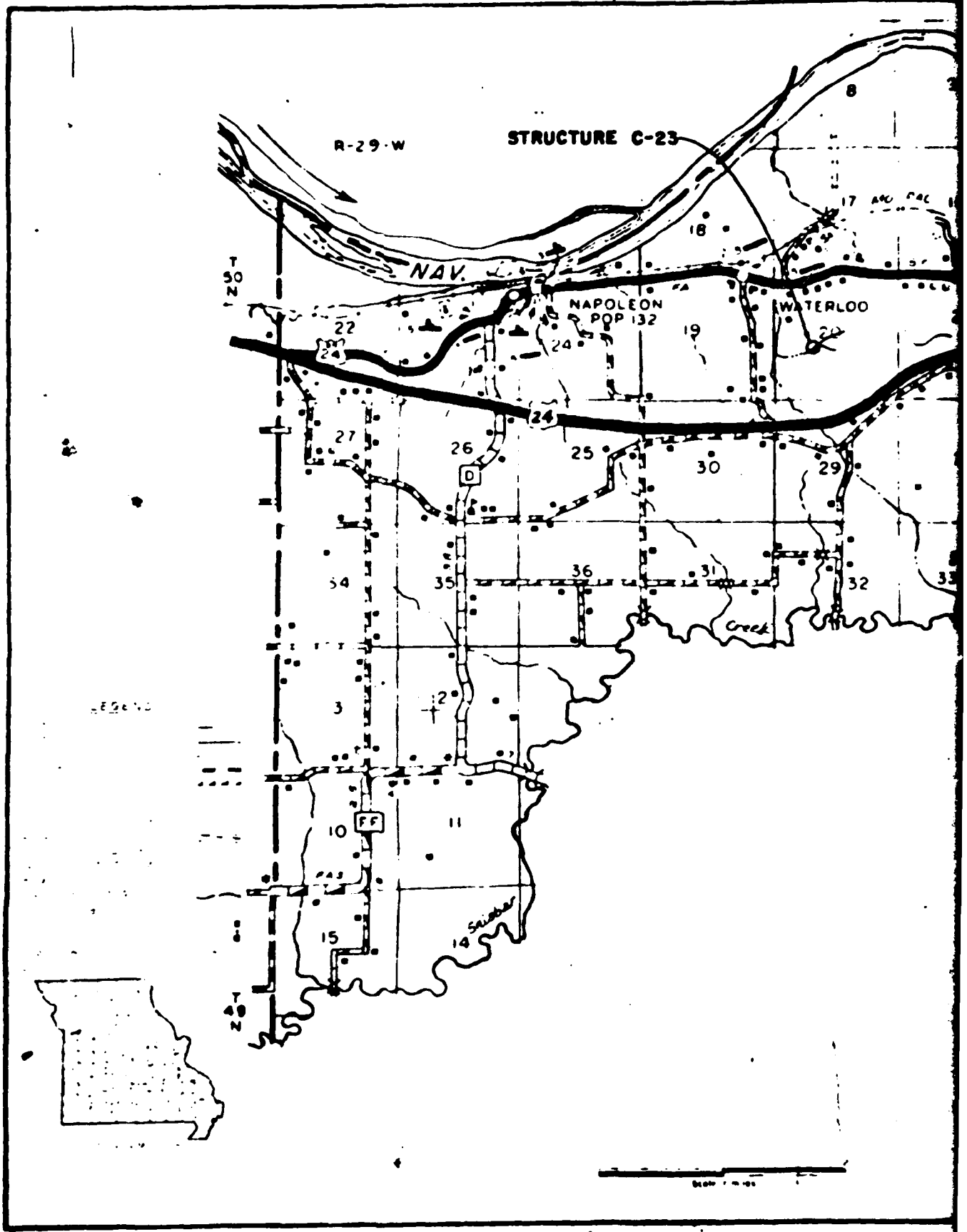
(3) Remove existing tree growth on the upstream face of the dam and remove all future tree and brush growth on a yearly basis. Cut the high grass around the primary spillway to prevent restrictions.

(4) Fill the animal burrow. Correct the minor erosion activity at the embankment-abutment contact on the downstream side of the dam and place riprap in these areas to minimize erosion in the future.

(5) Check the downstream slope periodically for seepage and stability problems. If wet areas or seepage flows are observed, or if sloughing is noted, then the dam should be inspected and the situation evaluated by an engineer experienced in design and construction of dams.

(6) A detailed inspection of the dam should be made at least every 5 years by and engineer experienced in the design and construction of dams. More frequent inspections may be required if slides, seeps, or other items of distress are observed.

APPENDIX A


R-29-W
STRUCTURE C-23
NAV.
NAPOLEON
POP 132
WATERLOO
T 50 N
T 49 N
8
17
18
19
20
22
24
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36
3
2
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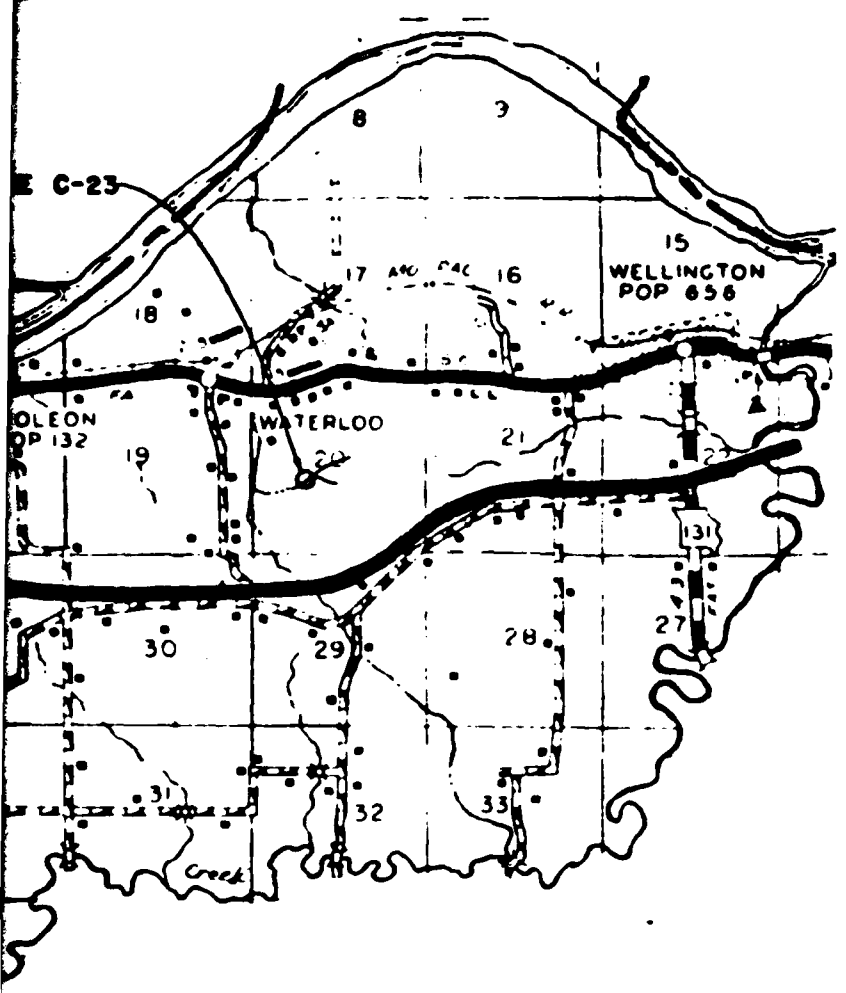
15
D
FF
Creek



INDEX OF DRAWINGS	
TITLE	SHEET No.
Cover Sheet	1
General Plan of Reservoir	2
Plan of Embankment & Spillways	3
General Layout	4
Foundation Drainage System	5
Pipe Requirements	6
Outlet Details	7
Antiseep Details	8
Inlet Details	9 & 10
Trash Rack Details	11
Fence Details	12
Standard Details	13
Plan - Geologic Investigation	14
Profile - Geologic Investigation	15
Cross Sections - Geologic Investigation	17

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAIL PLANS FOR WELLINGTON-NAPOLEON WATERSHED PROTECTION AND FLOOD PREVENTION PROJECT

LAFAYETTE COUNTY, MISSOURI
IN COOPERATION WITH
SOIL AND WATER CONSERVATION DISTRICT
OF LAFAYETTE COUNTY
LAFAYETTE COUNTY COURT

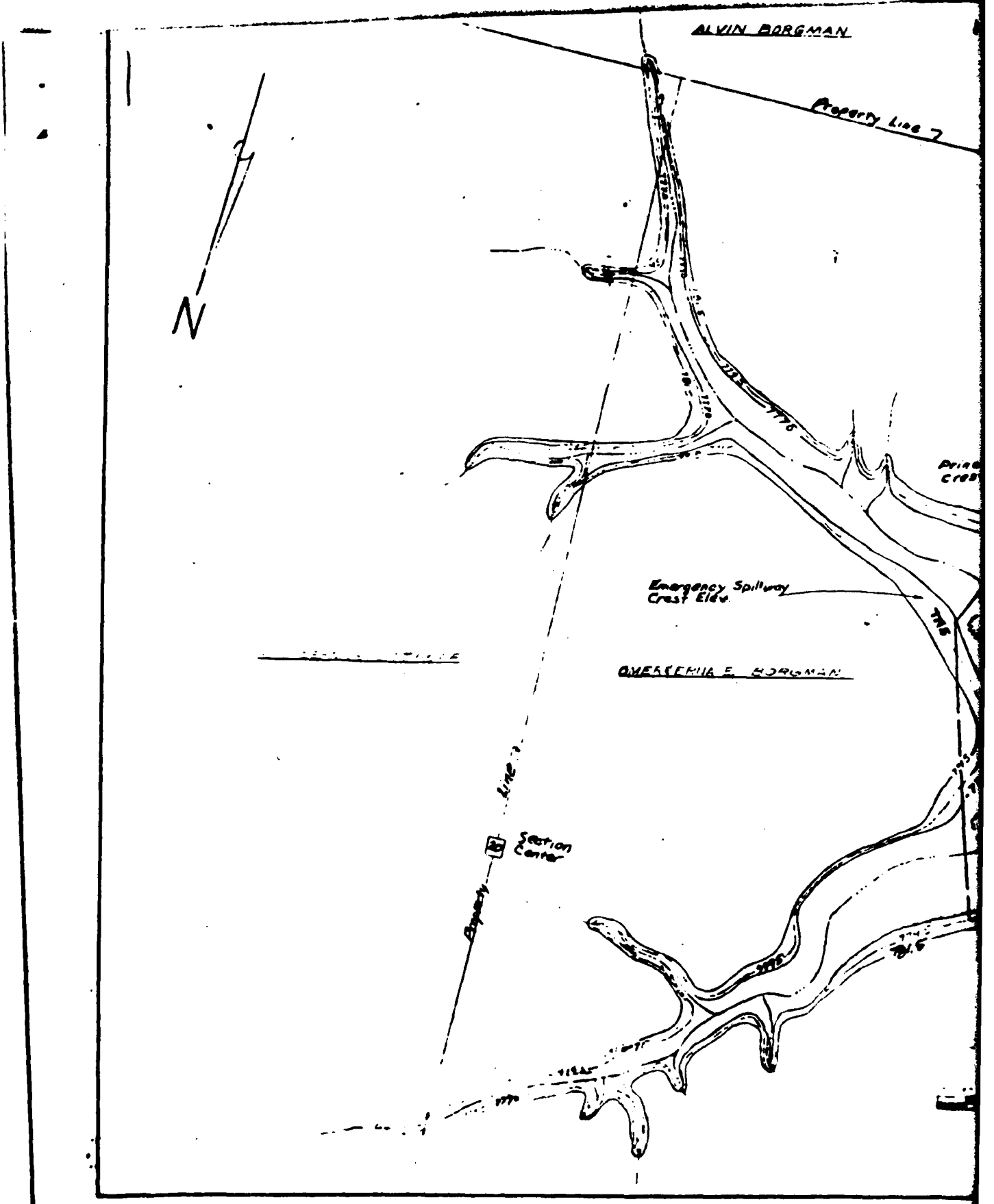
STRUCTURE C-23

AS BUILT 1-23-70

James [illegible]	8-2-67
Elmer D. Bueler	8/16/67

SHEET 1 APPENDIX A

Sheet 1 of 17

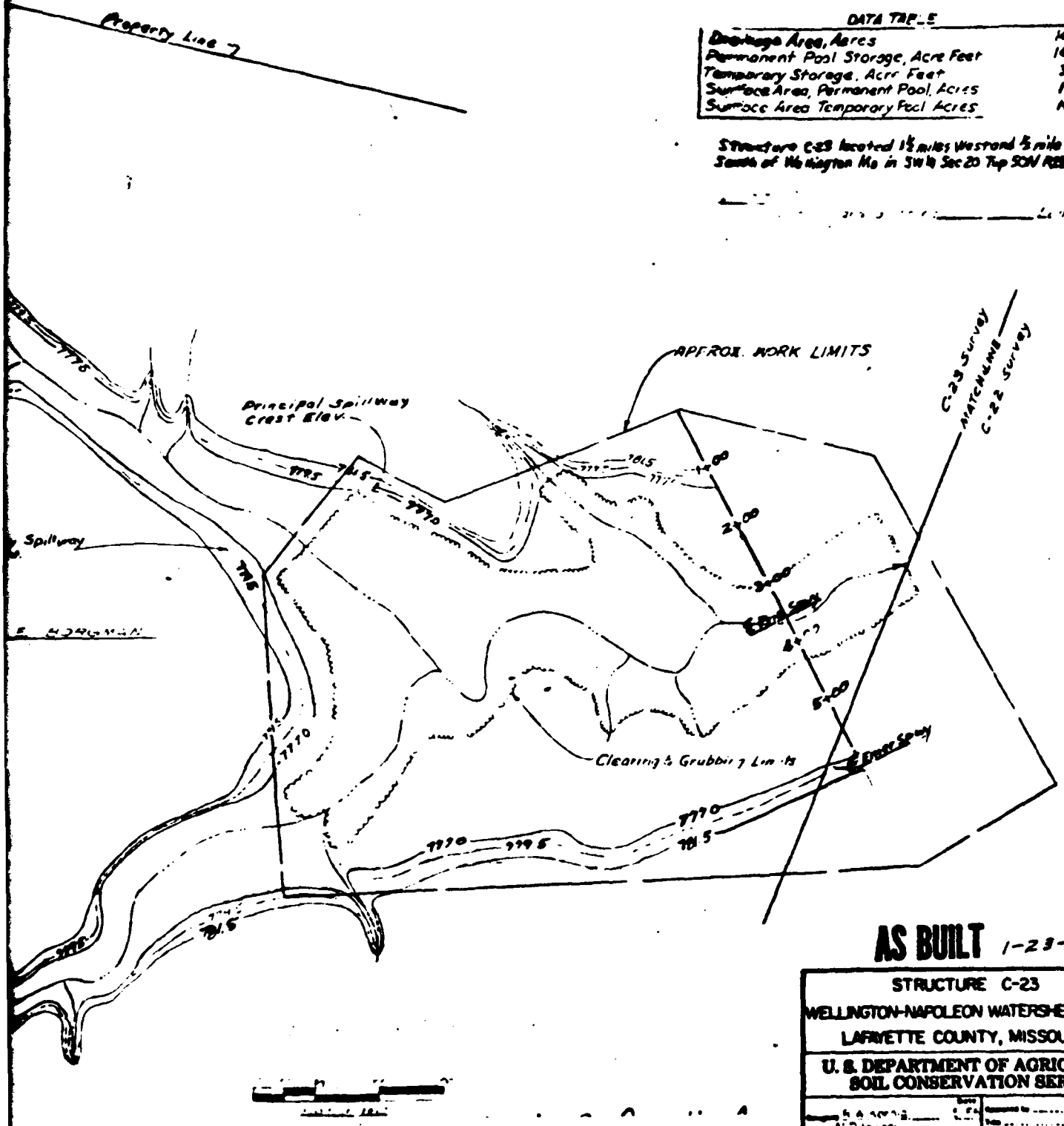


N BORGMAN

2

DATA TABLE	
Drainage Area, Acres	146.0
Permanent Pool Storage, Acre Feet	147.7
Temporary Storage, Acre Feet	368
Surface Area, Permanent Pool, Acres	11.8
Surface Area Temporary Pool Acres	16.3

Structure C-23 located 1½ miles Westand ¾ mile South of Wellington Mo in SW¼ Sec 20 Twp 50N R28W



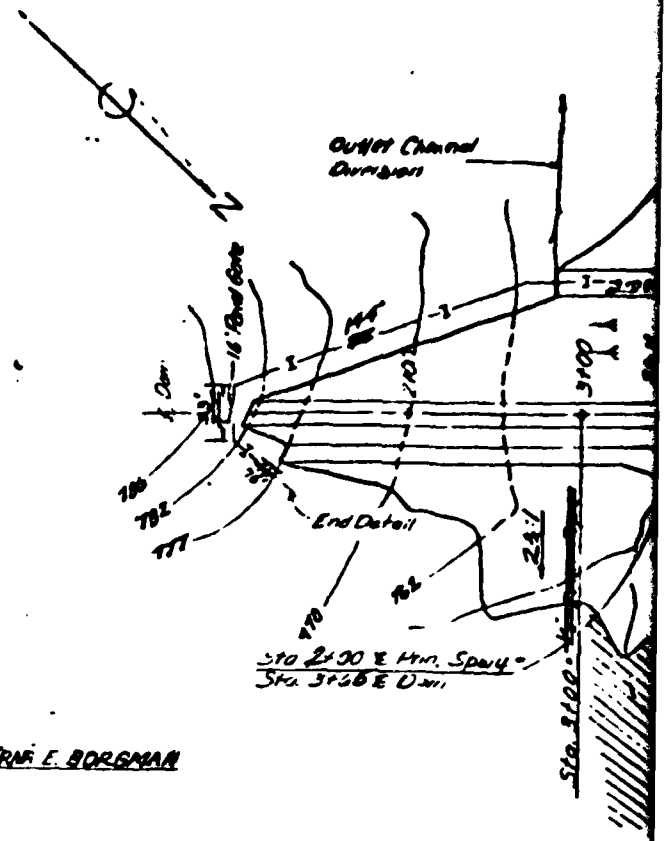
AS BUILT 1-23-70

STRUCTURE C-23
WELLINGTON-NAPOLEON WATERSHED PL 566
LAFAYETTE COUNTY, MISSOURI
U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

SHEET 2 APPENDIX A

EM C-22 Elev 784.25

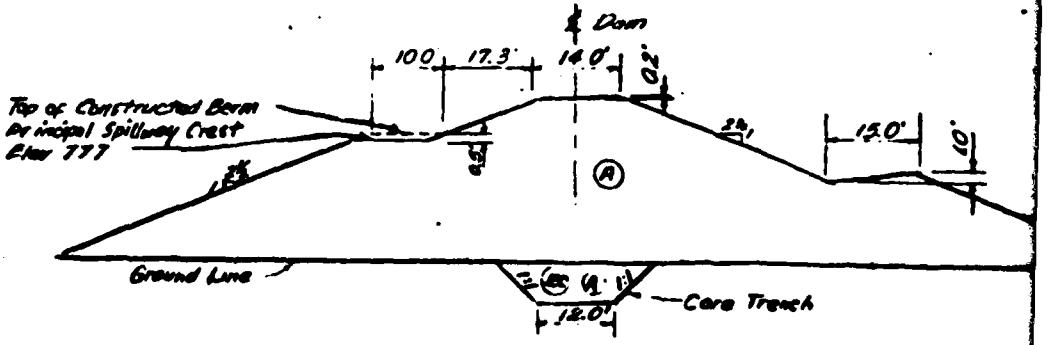
Top of brass cap in concrete monument located in fence corner on emergency spillway end of dam approx. 25' north of west gate. SW¼ Sec. 20, T 80N, R 28W



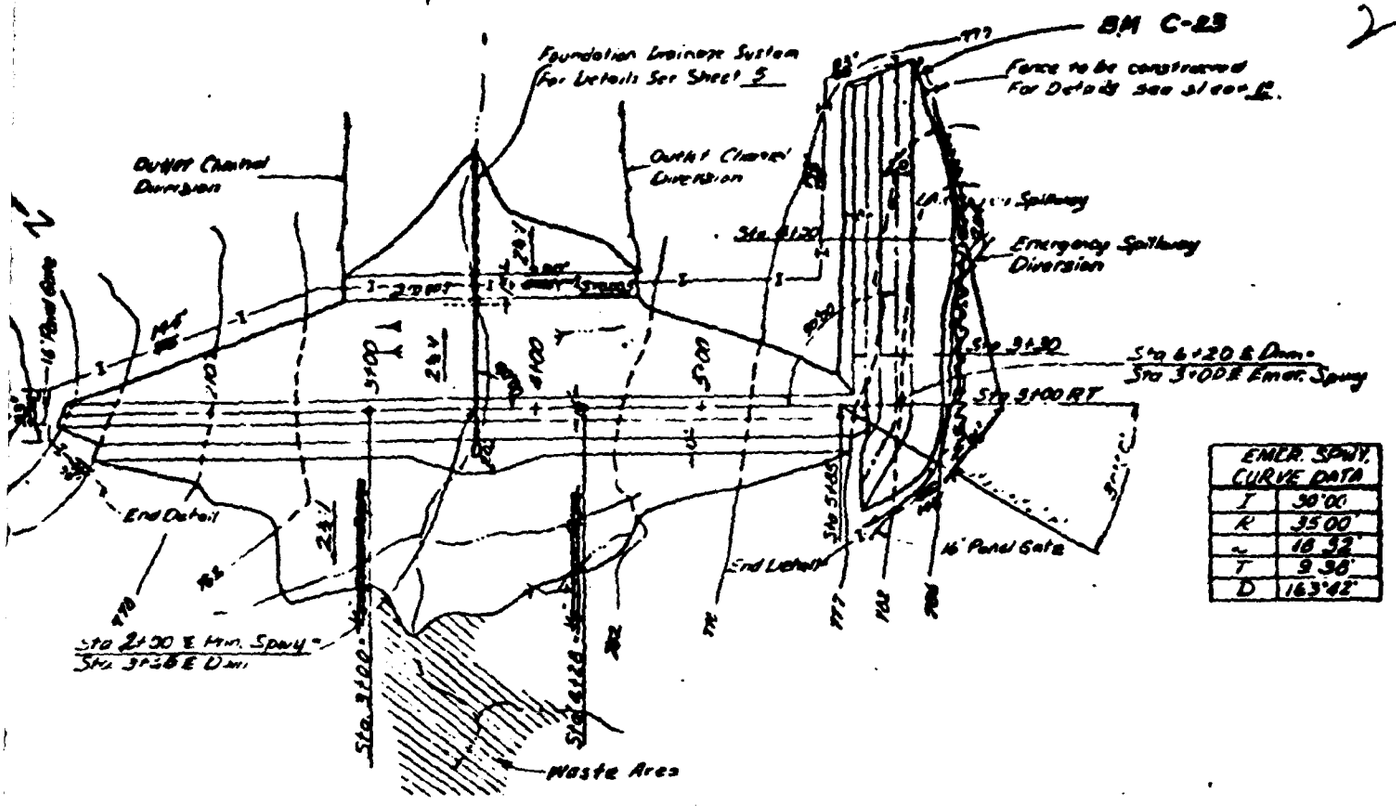
OMER & ERNE E. BORGMAN

PLAN OF EMBA

50



TYPICAL SECTION OF EMBANKMENT



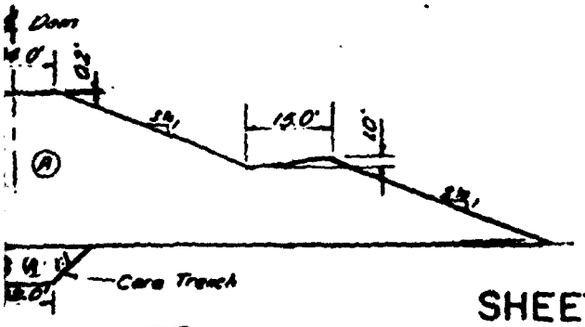
EMER. SPWY. CURVE DATA	
I	30°00'
R	35.00'
∼	18.32'
T	9.36'
D	163°42'

QUANTITIES	
Excavation Common in	
Core Trench	1222 Cu Yds
Stream Channel	886 Cu Yds
Total	2108 Cu Yds
Earth Fill	
Class A	42,289 Cu Yds
Fence-Barbed Wire	1274 Lin Ft.

PLAN OF EMBANKMENT AND SPILLWAYS

50 0 50 100

Scale in Feet



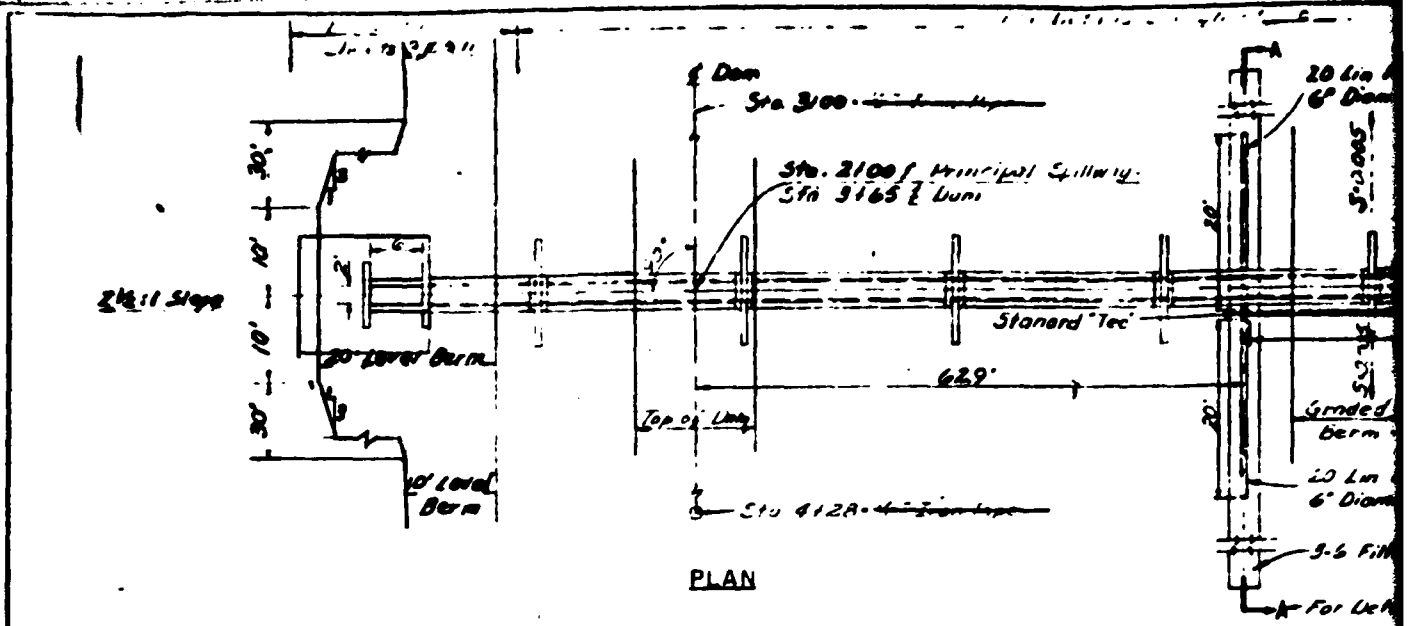
OF EMBANKMENT

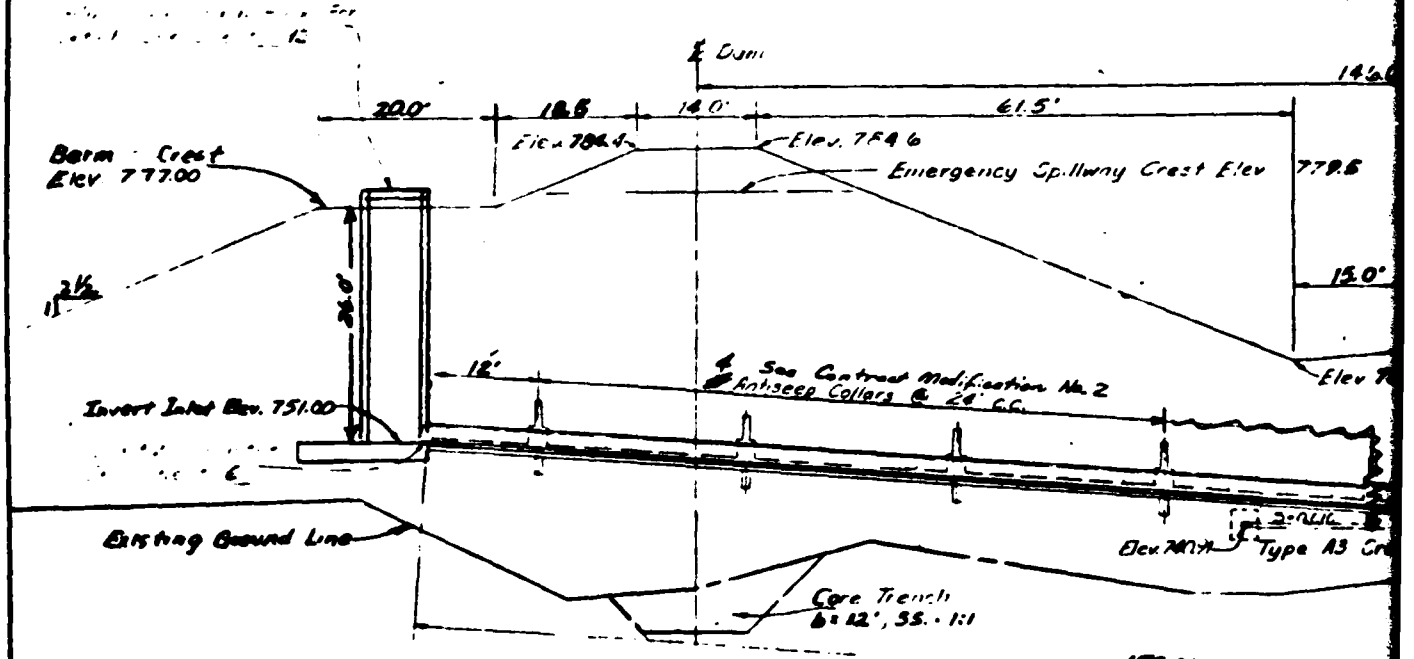
AS BUILT 1-23-70

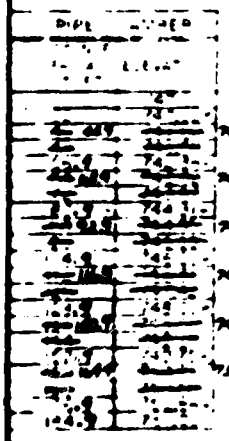
STRUCTURE C-23
WELLINGTON-NAPOLEON WATERSHED PL566
LAFAYETTE COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET 3 APPENDIX A

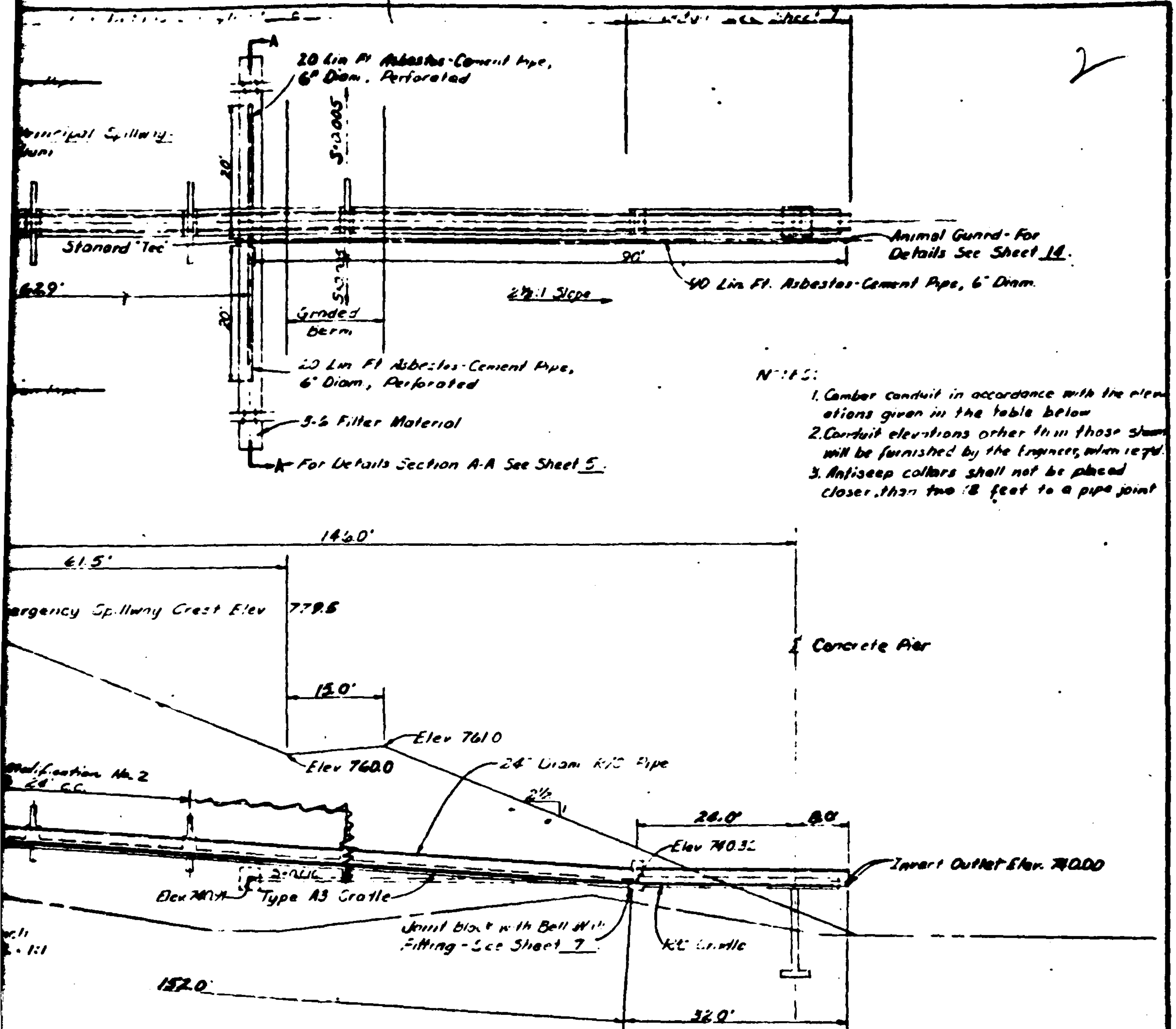






QUANTITIES

Concrete-Class 2500, Plain _____
Concrete-Class 4000, Reinforced _____
Steel bar Reinforcement _____
Pipe Conduit-Reinforced Concrete (Pressure) 24" Diam. Steel Ring Type Joint _____
Excavation Trial Trench _____
Pipe, Asbestos-Cement (Pressure) 6" Diam., Class _____
Pipe, Plastic Sewer 6" Diam., Class PS _____
Impervious Fill-Filter Material _____
Installing Vertical Drains _____



NOTES:

1. Camber conduit in accordance with the elevations given in the table below
2. Conduit elevations other than those shown will be furnished by the Engineer, when req'd.
3. Antiseep collars shall not be placed closer than two (2) feet to a pipe joint

AS BUILT 1-23-70

STRUCTURE C-23

QUANTITIES

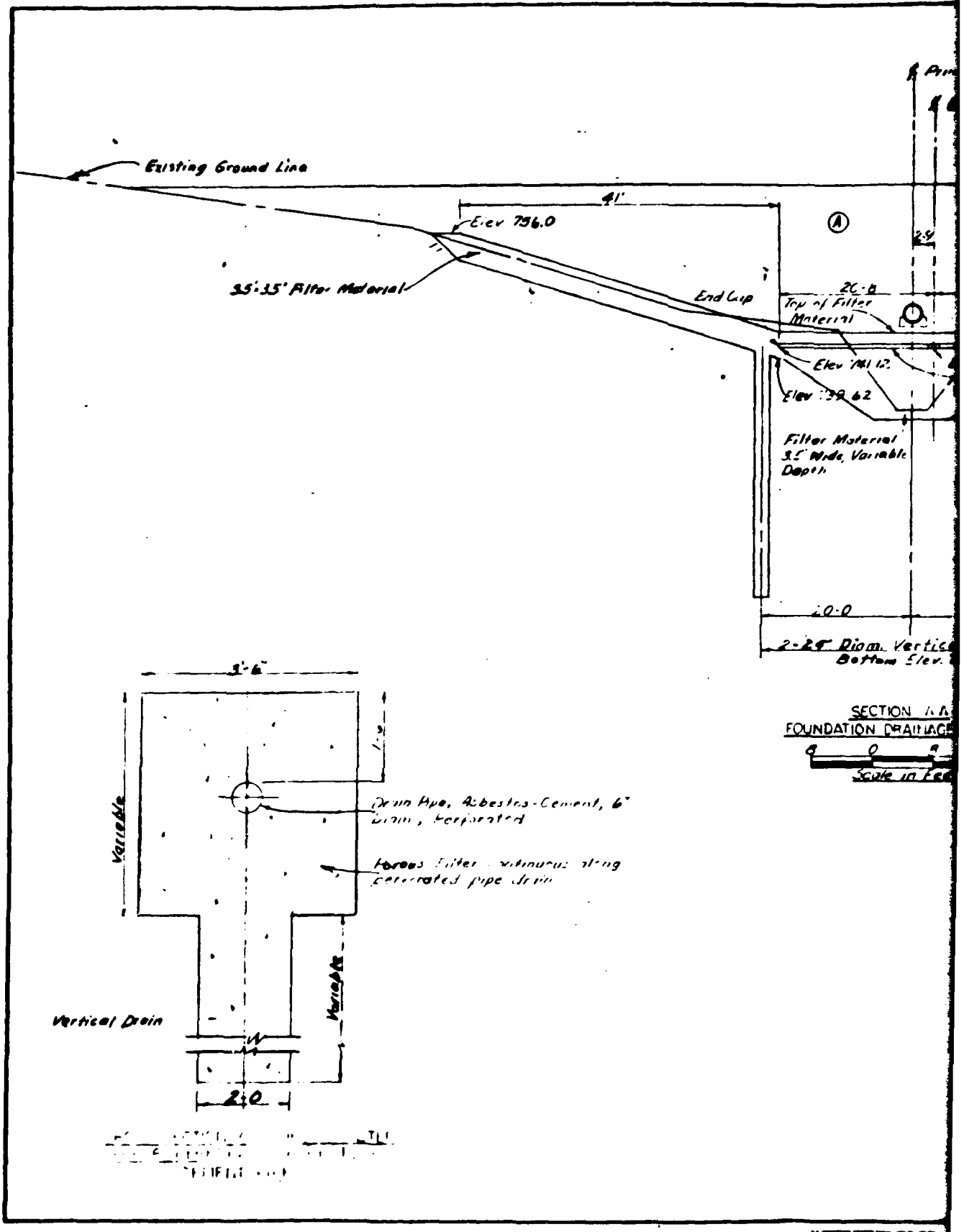
	18.0 Cu Yds
	~~32.2~~ 33.8 Cu. Yds
	~~[illegible]~~ 2632 Pounds
(Pressure) 24" Diam. Steel Ring Type Joint & Rubber Gasket	184 Lin Ft
	Lump Sum
[illegible]	40 Lin Ft
[illegible], Class [illegible]	90 [illegible]
	~~60~~ 109 Cu. Yds
	64 Lin Ft

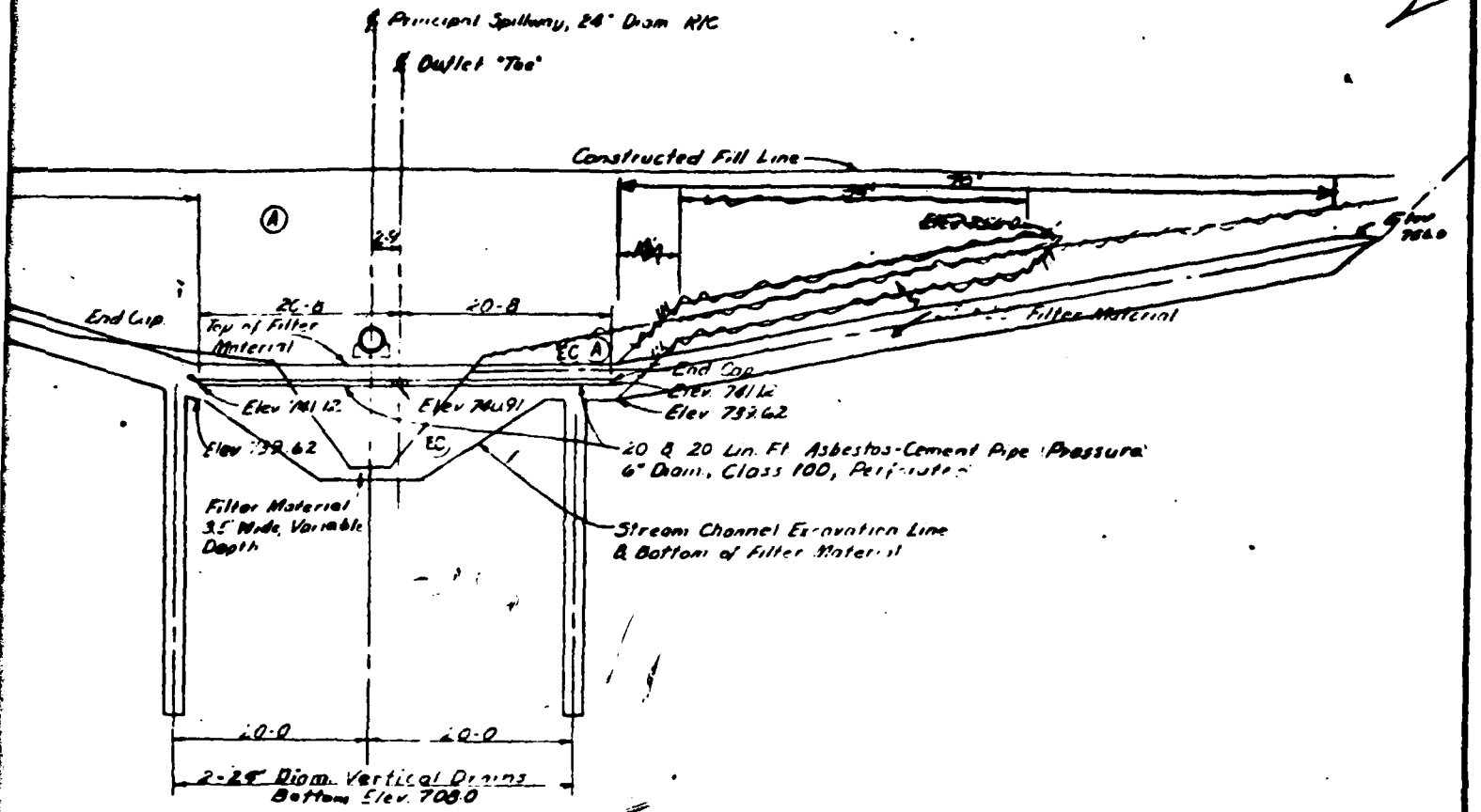
R/C DROP INLET FOR 24" DIAM. PIPE
GENERAL LAYOUT
WELLINGTON-NAPOLEON WATERSHED P.L.566
LAFAYETTE COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

ES-25170

SHEET 4 APPENDIX A





SECTION A-A
FOUNDATION DRAINAGE SYSTEM

0 8 16
Scale in Feet

NOTES

1. The filter material shall be a reasonably well graded sand-gravel mixture with 50 to 85 % passing a No. 4 sieve, maximum size of 3" and not more than 5% passing a No 200 sieve
2. For drain support detail see sheet 14

AS BUILT 1-23-70

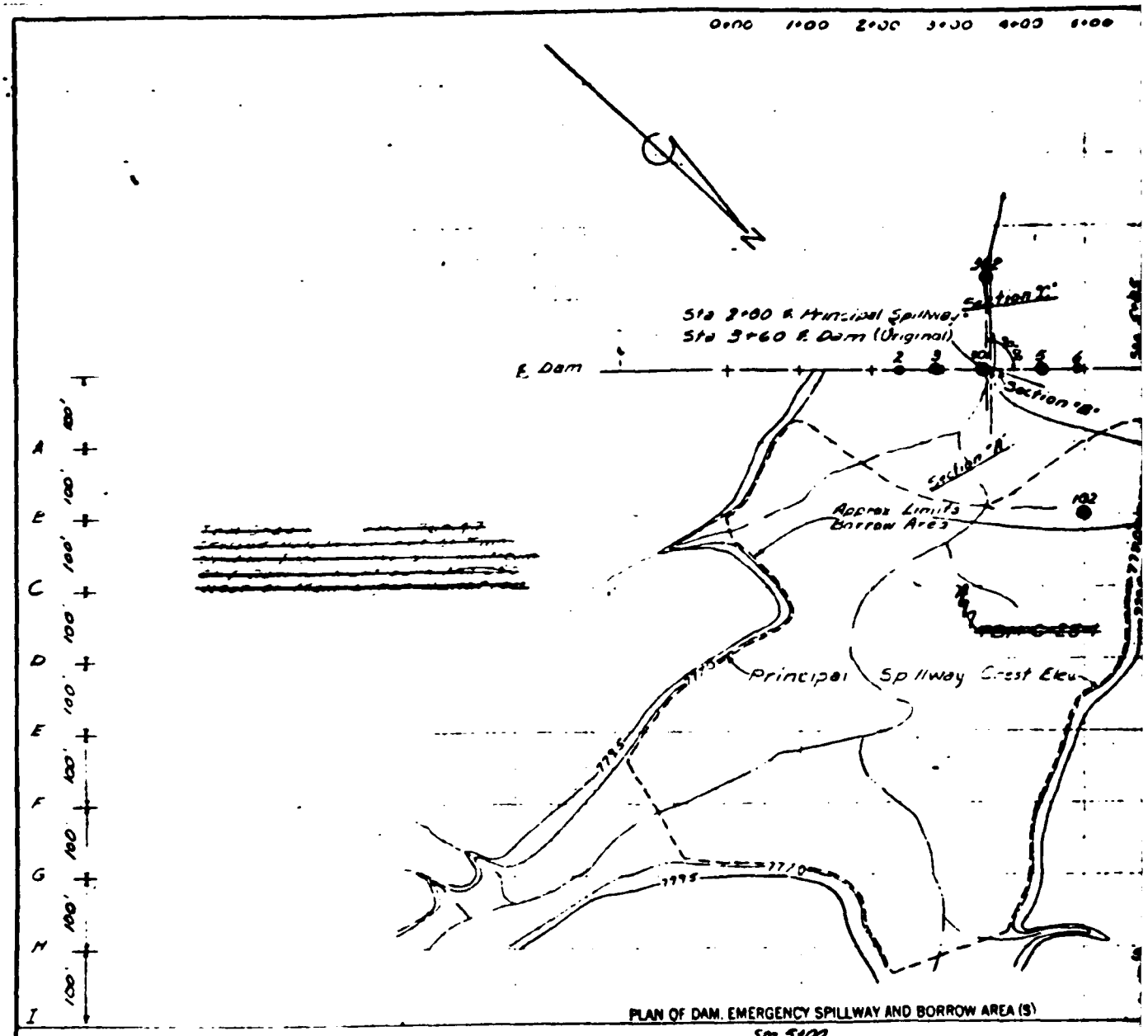
STRUCTURE
FOUNDATION DRAINAGE SYSTEM
WELLINGTON AND CLEAR WATERFIELD RD.
LAFAYETTE COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	40-26170

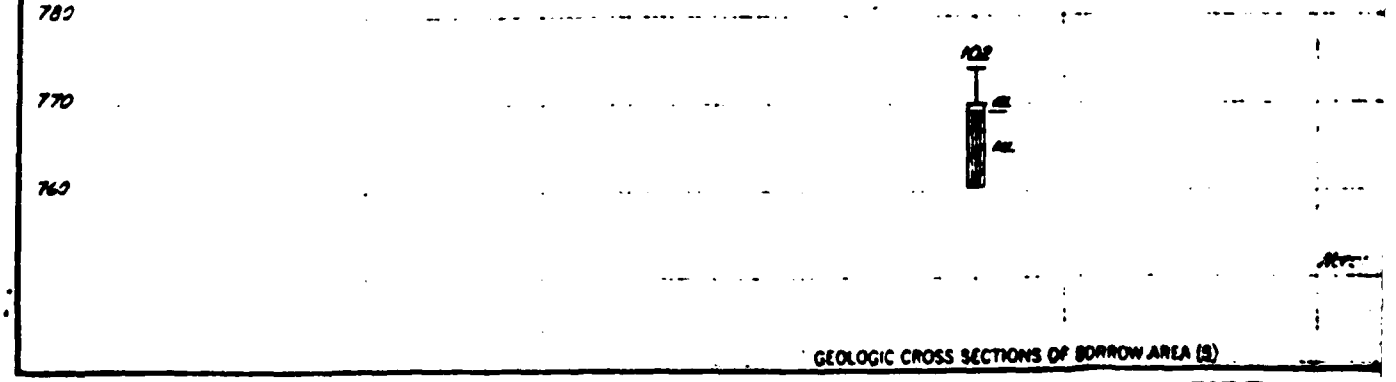
SHEET 5 APPENDIX A

APPENDIX B

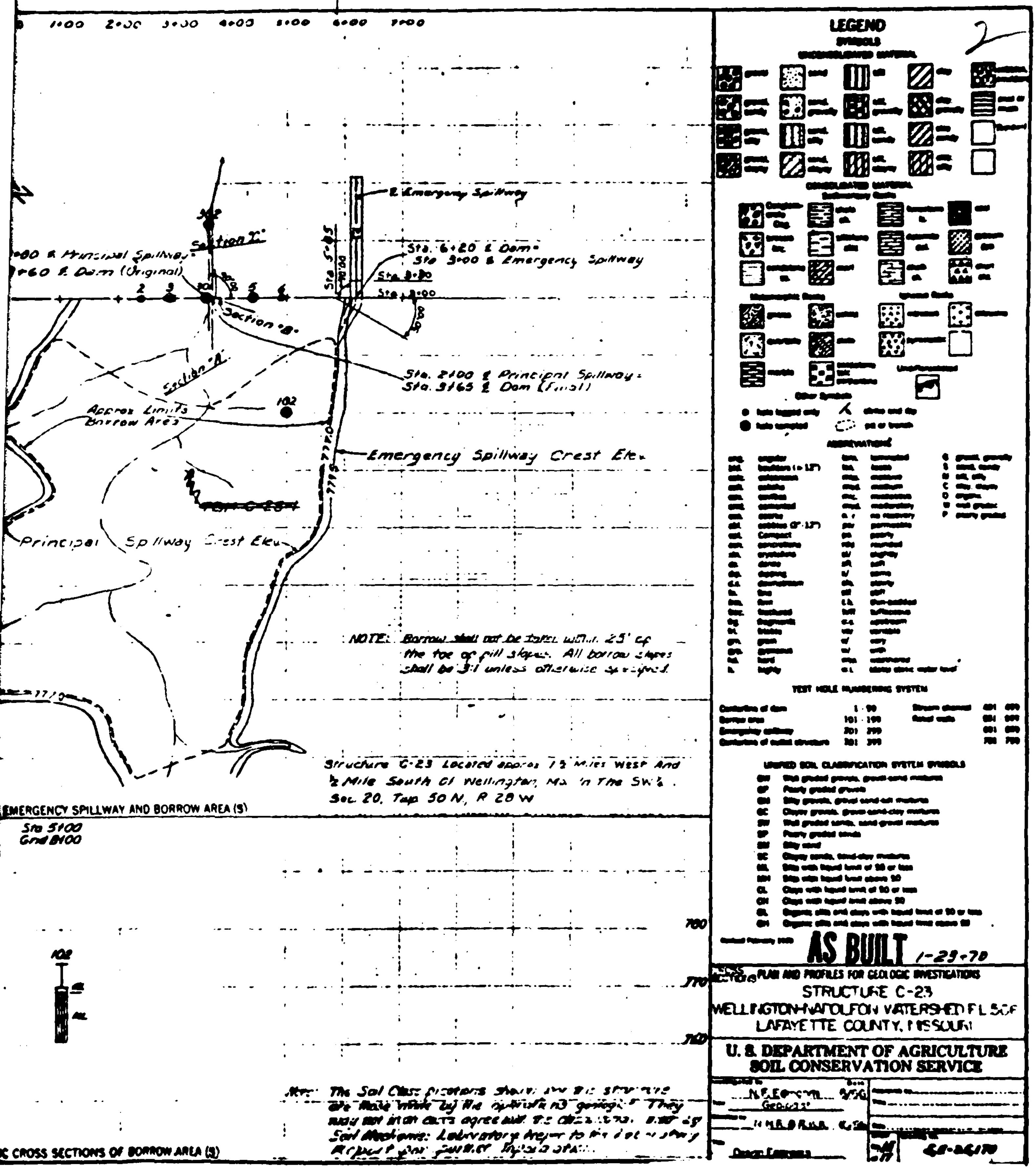


PLAN OF DAM, EMERGENCY SPILLWAY AND BORROW AREA (S)

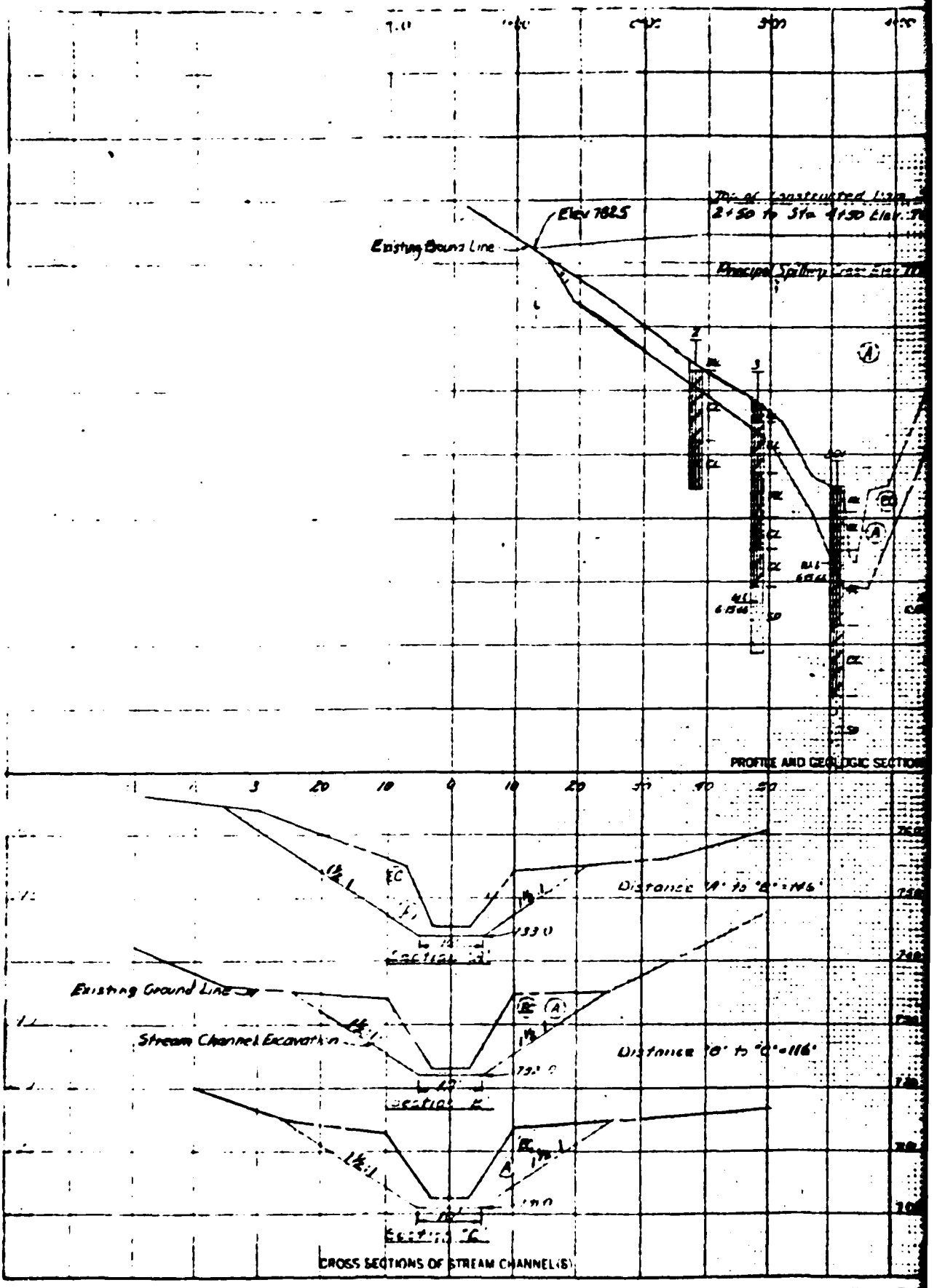
Sta 5+00
Grid B400

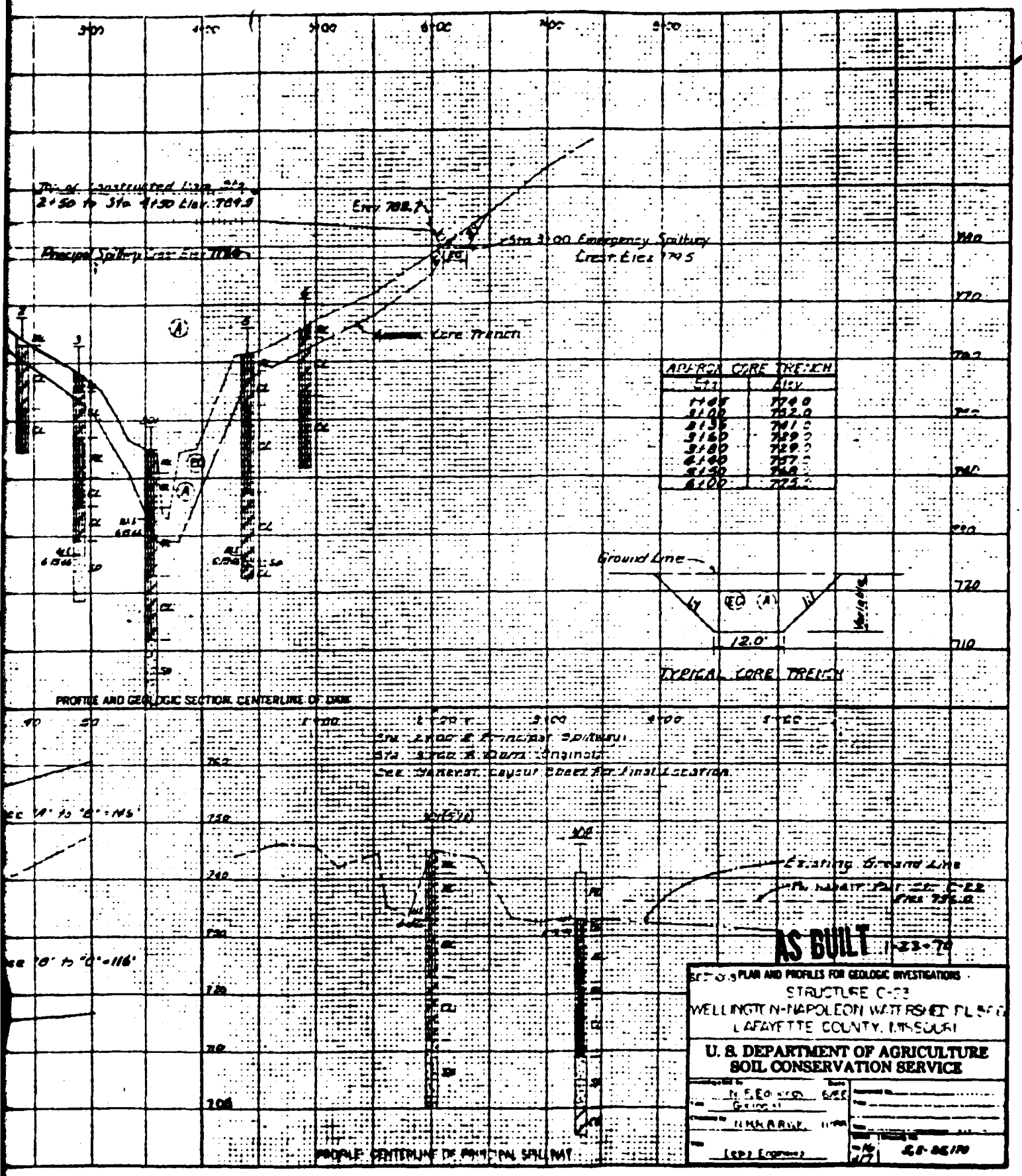


GEOLOGIC CROSS SECTIONS OF BORROW AREA (S)



SHEET I APPENDIX B





SHEET 2 APPENDIX B

Sheet 1 of 3

10-69

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

GENERAL

State Missouri County Lafayette ; ¼, SW ¼, Sec. 20, T 50N R 25W ; Watershed Wellington-Napoleon

Subwatershed _____ Fund class WP-(S)-10 (FP-2, WP-1, etc.) Site number C-23 Site group I Structure class b

Investigated by Nuel F. Edwards, Geo. (signature and title) Equipment used Mobile B-40 (type, size, make, model, etc.) Date 6-14-66

SITE DATA

Drainage area size .23 sq. mi., 146 acres. Type of structure DI 24"RC Purpose Stabilization, Sediment, Detention

Direction of valley trend (downstream) SW Maximum height of fill 49.5 feet. Length of fill 490 feet.

Estimated volume of compacted fill required 30,000 yards

STORAGE ALLOCATION

	Volume (ac. ft.)	Surface Area (acres)	Depth at Dam (feet)
Sediment	160.0	12.8	45.0
Floodwater	20.5	14.3	46.5

SURFACE GEOLOGY AND PHYSIOGRAPHY

Physiographic description Mo. River Loess Hills Topography Rolling Attitude of beds: Dip — Strike —

Steepness of abutments: Left 15 percent; Right 14 percent. Width of floodplain at centerline of dam 0 feet

General geology of site: The site is located in the loess hills approximately 3/4 mile from the Missouri River floodplain and is in an area underlain with bedrock of the Upper Desmoinesian Series of the Pennsylvanian System which are characterized as cyclic deposits of principally limestone and shale.

SHEET 3 APPENDIX B

rm SCS-376B
Sheet 2 of 3

USDA-SCS

-59

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

ATURE Centerline of Dam, Principal Spillway, Borrow Area
(Centerline of Dam, Principal Spillway, Emergency Spillway, the Stream Channel, Investigations for Drainage of Structure, Borrow Area, Reservoir Basin, etc.)

DRILLING PROGRAM

Equipment Used	Number of Holes		Number of Samples Taken		
	Exploration	Sampling	Undisturbed (state type)	Disturbed Large	Disturbed Small
FA 4"	2	1		1 L.Bag	
Sp.T		4			
Tube 3"		1	2 Shelby		20 Jar
Total	2	6	2	1	20

SUMMARY OF FINDINGS
(include only factual data)

The abutments are deep loess. The material below the developed soil profile is classified CL except for material classified ML in test hole 3 from 11 to 13 feet. Blow counts in the loess ranged from 2.5 to 16. The foundation of the principal spillway is medium to stiff alluvium classified ML. Sand classified SP was encountered in test hole 3 and 5 and also occurs at a relatively uniform elevation and thickness in test holes 301 and 302. The weakest material of the formation had a blow count of 2.5 in test hole 5. The emergency spillway cuts will be in the loess soil. The channel is active and cutting. There is sufficient borrow available within 500 feet of the centerline of the dam.

SHEET 4 APPENDIX B

Form SCS-376C
Sheet 2 of 3
For In-Service Use Only

USDA-SCS

-69

DETAILED GEOLOGIC INVESTIGATION OF DAM SITES

State Missouri County Lafayette Watershed Wellington-Napoleon Subwatershed

Site number C-23 Site group I Structure class b Investigated by Muel F. Edmonds, Geo. (signature and title) Date 6-14-66

INTERPRETATIONS AND CONCLUSIONS

The soft loess in test hole 5 is unusual for the loess in this area. There was poor recovery on the sample and some doubt as to the validity of the blow count. Undisturbed samples were taken of the weakest material in the foundation of the principal spillway. The sand in test holes 3 and 5 is interpeted as pockets or lens and as a stratum occurring at relatively uniform elevation and thickness beneath the principal spillway. This material had a blow count of 3 in test holes 301 and 302 and is permeable. The sand is underlain with stiff CH. There is an area of slopewash classified ML on both gully banks.

Emergency spillway cuts are shallow and in loess soil and was not drilled or sampled. The channel is active and has 1 to 2 feet of soft channel fill principally at the sides of the channel. All borrow will be the loess soil. Since this material is uniform in texture and depth, it was felt that one borrow sample was sufficient.

There is an estimated 37,000 cubic yards of compacted fill available below the crest elevation of the principal spillway within 500 feet of the centerline of the dam.

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA GEN. REG. NO. 27

5010-106

UNITED STATES GOVERNMENT

Memorandum

Design

TO : James M. Dale, State Conservation Engineer, SCS, Columbia, Missouri 65201

DATE: October 14, 1966

FROM : Roland B. Philips, Acting Head, Soil Mechanics Unit, SCS, Lincoln, Nebraska 68508

SUBJECT: ENG 22-5, Missouri WP-08, Wellington-Napoleon Site C-23 (Lafayette County)

ATTACHMENTS

1. Form SCS-354, Soil Mechanics Laboratory Data, 4 sheets.
2. Form SCS-128 and 128A, Consolidation Test, 4 sheets.
3. Form SCS-127, Permeability Test, 1 sheet.
4. Form SCS-355A, Triaxial Shear Test, 2 sheets.
5. Form SCS-352, Compaction and Penetration Resistance, 1 sheet.
6. Form SCS-357, Summary - Slope Stability, 3 sheets.

DISCUSSION

FOUNDATION

A. Classification: The loess and loess derived alluvial materials that blanket the site to depths of 30 feet or more classify generally as low plasticity CL and ML materials with approximately 85% fines.

A sandy layer underlies the floodplain materials at the 30-foot depth. A sample of the deep sandy material, 67W381 (3.4), contained 16% fines, 94% sand and 11% finer than the 2 micron size clay. The deep sandy samples 67W370 (301.5) and 67W377 (302.5) class as SP-SM materials with 9 and 12% fines.

B. Dry Unit Weight: Core opening dry density of the shallowest core sample 67W371 (301.6) was 1.49 gm/cc; however, the consolidation test specimen had an initial dry density of only 1.22 gm/cc and the shear test specimens of sample 67W371 had an average dry density of only 1.34 gm/cc.

The deeper core sample, 67W372 (301.7), from the 18 to 19.5-foot depths had a core opening dry density of 1.48 gm/cc.

Blow count for the deeper material was 5 blows per foot. The material at the 30-foot depth and below had blow count of 9 blows per foot.

The loess material of the abutments was fairly moist but was above the permanent water table. It had blow count generally in the range of 5 to 8 blows/foot.

2 -- James M. Dale -- 10/14/66
Roland B. Phillips
Subj: ENG 22-5, Missouri WP-08, Wellington-Napolean, Site C-23

C. Consolidation: A one-dimensional consolidation test was made on the shallow CL alluvial sample 67W371 (301.6). The sample had an initial dry density of only 1.22 gm/cc and contained only 10.8% moisture. The sample was loaded to 4000 psf at natural moisture and then saturated under load to determine the extent of the rapid consolidation that usually occurs when a dry low density silt material is saturated under load. The sample consolidated 11% (from 2 to 13%) when saturated under a 4000 psf load. Approximately 15% total consolidation was obtained from the 5000 psf load which is the equivalent loading of the proposed embankment with a top elevation of 782.5.

The alluvium from 10 to 22 feet in test hole No. 301, which had a blow count of 5 blows per foot, is expected to have a consolidation potential of approximately 4% based on a comparison with the consolidation tests from sites C-21 and C-22.

The 9 and 10 blow count CL materials below 22 feet are estimated to have a consolidation potential of 2% under the proposed 40-foot high embankment.

D. Permeability: A falling head permeability test was made on the low density consolidation test specimen during the consolidation testing. A semi-log plot of the void ratio versus permeability gives a normal straight line. Extrapolation of the plot to the starting void ratio shows a permeability rate of approximately 2 ft/day for the material at its initial density. The specimen had a permeability rate of 0.05 ft/day under the 4000 psf loading at a density of 1.41 gm/cc.

The permeability of the higher blow count (n = 9) CL material is expected to be approximately 0.001 ft/day. Permeability of the deep underlying SP-SM materials is estimated at 10 ft/day. (From Slichter's permeability charts in "Low Dam")

Uplift appears to present a problem in the outlet channel area. Calculations based on a 20-foot blanket under the channel (K_b = .001 ft/day) over a 10-foot aquifer(K_f = 10 ft/day) show a safety factor less than 1.0 if relief is not provided. A deeply eroded plunge basin could easily reduce the 20-foot blanket thickness and blowout or boils would occur as the permanent water table is near the top of the dam in this grade control structure. A relief well on each side of the principal spillway at c/b = 0.8 would effectively relieve the uplift pressure.

3 -- James M. Dale -- 10/14/66
Roland B. Phillips
Subj: ENG 22-5, Missouri WP-08, Wellington-Napolean, Site C-23

E. Shear Strength: A consolidated, undrained triaxial shear test on the low density CL sample, 67W371 (301.6) gave saturated total stress shear parameters of ϕ = 20.5°, c = 425 psf.

The deeper, more dense foundation materials are expected to be as strong or stronger than the shallow sample, 67W371 (301.6).

EMBANKMENT

A. Classification: The only borrow sample submitted, 67W387 (102.1), was a moderately plastic CL material with 93% fines and 24% smaller than the 2 micron size.

B. Compacted Dry Density: Standard Proctor compaction (ASTM D-698) yielded a maximum dry density of 103.5 pcf with an optimum moisture content of 19.0%.

C. Shear Strength: A consolidated, undrained triaxial shear test on remolded specimens of Sample 67W387 (102.1) at dry densities of approximately 93% of standard (98.6 pcf) gave saturated total stress shear parameters of ϕ = 10° and c = 1150 psf.

D. Consolidation: An average consolidation potential of 2% is estimated for the 40-foot high embankment across the floodplain.

STABILITY ANALYSIS

A modified Swedish circle method of analysis was used to analyze the embankment stability. Shear parameters of ϕ = 10° and c = 1150 psf were used to represent the shear strength of the embankment and parameters of ϕ = 20.5° and c = 425 psf were used to represent the foundation. The foundation parameters of ϕ = 20.5° and c = 425 psf from the shallow sample, 67W371, are rather low for the full 22 feet of foundation cut by the arcs in the floodplain section; however, satisfactory safety factors were obtained for the proposed design using the low values so further refinement is not necessary.

A safety factor of 1.41 was obtained for the 2 1/2:1 upstream slope of the maximum section with a 10-foot berm at elevation 778.0 (see trial No. 1 in the slope stability summary in the attachments). The downstream 2 1/2:1 slope without a drain but with a berm at elevation 760 gave a safety factor of 1.71 for the 49.5-foot high maximum section of the proposed Class "B" structure.

4 -- James M. Dale -- 10/14/66
Roland B. Phillips
Subj: ENG 22-5, Missouri WP-08, Wellington-Napolean, Site C-23

RECOMMENDATIONS

A. Site Preparation: Removal of 8 feet of the low density surface alluvium in the gully on each side of the present channel is recommended to reduce the horizontal strain on the conduit.

B. Centerline Cutoff: A normal width (~~10'~~ 12') cutoff approximately 5 feet deep is recommended to penetrate the zone of surface weathering and slope wash materials. Side slopes of 1:1 are adequate for the cutoff trench. Baskfill with CL borrow material compacted to 95% of standard.

C. Principal Spillway: Pipe elongation calculations for ℄ station 3+50 based on 25 feet of compressible foundation (with 8 feet of the low density surface material removed) with an average consolidation potential of 4.0% show a horizontal strain of approximately 0.01 ft/ft for a 45-foot high embankment.

A ϕ angle of 25° is recommended for conduit loading calculations.

Backfill with CL material compacted to a minimum density of 95% of standard.

D. Drainage: Relief wells at c/b = 0.8 on each side of the principal spillway are recommended to penetrate the sand layer at elevation 712 to relieve uplift pressures in the plunge basin to avoid blow-out or "boils".

E. Embankment Design: The following are recommended:

1. Place the CL borrow materials in a homogeneous embankment at a minimum density of 95% of standard. Place materials at a moisture content on the wet side of optimum.

2. Provide 2 1/2:1 embankment slopes both upstream and downstream.

3. Provide a 10-foot upstream berm at elevation 778.0, and a 15-foot downstream berm at elevation 760.0.

4. Provide an overfill of 2.0 feet across the floodplain of the gully from station 3+00 to station 4+50 to compensate for residual foundation and embankment settlement.

Prepared by:

Edgar F. Steele

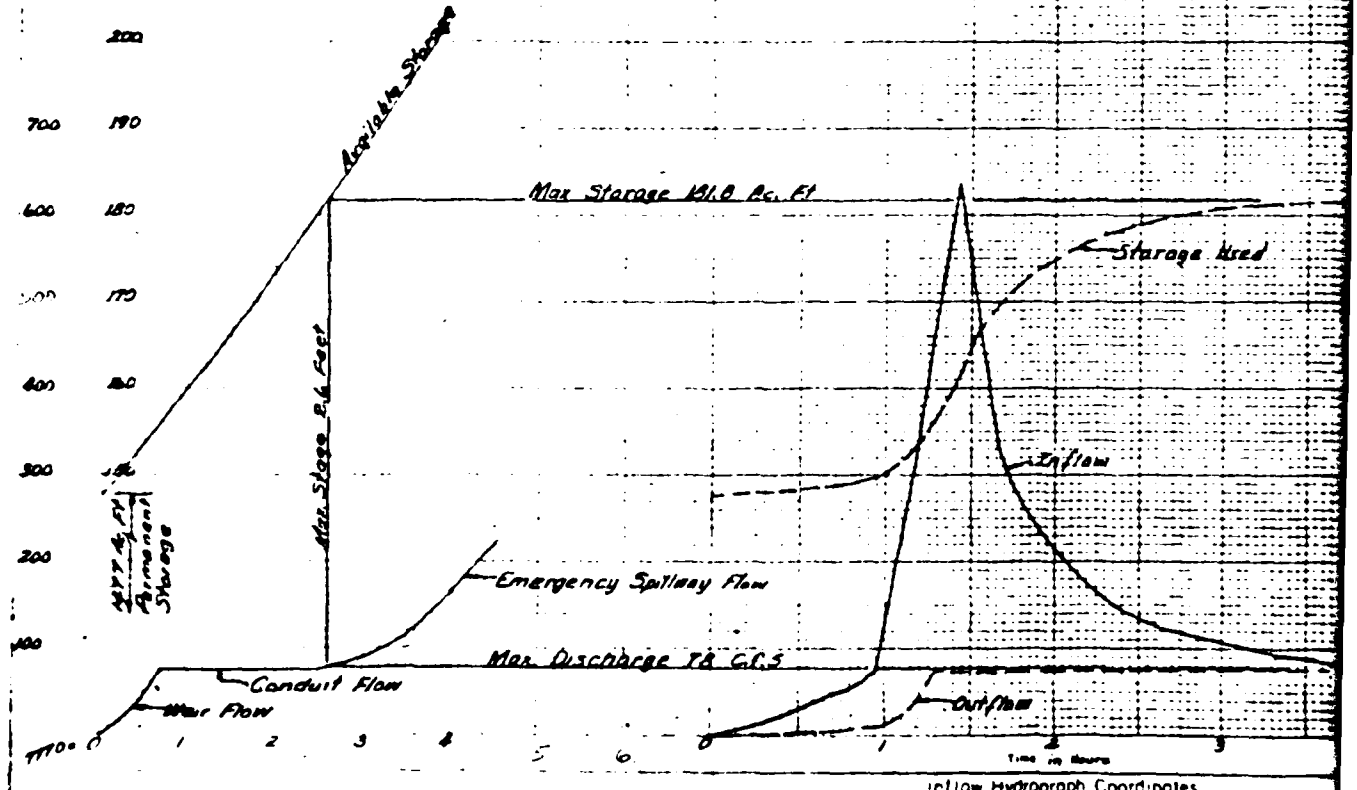
Attachments

cc:
James M. Dale (2) Project Engineer
E. S. Alling
D. S. McVicker

SHEET 9 APPENDIX B

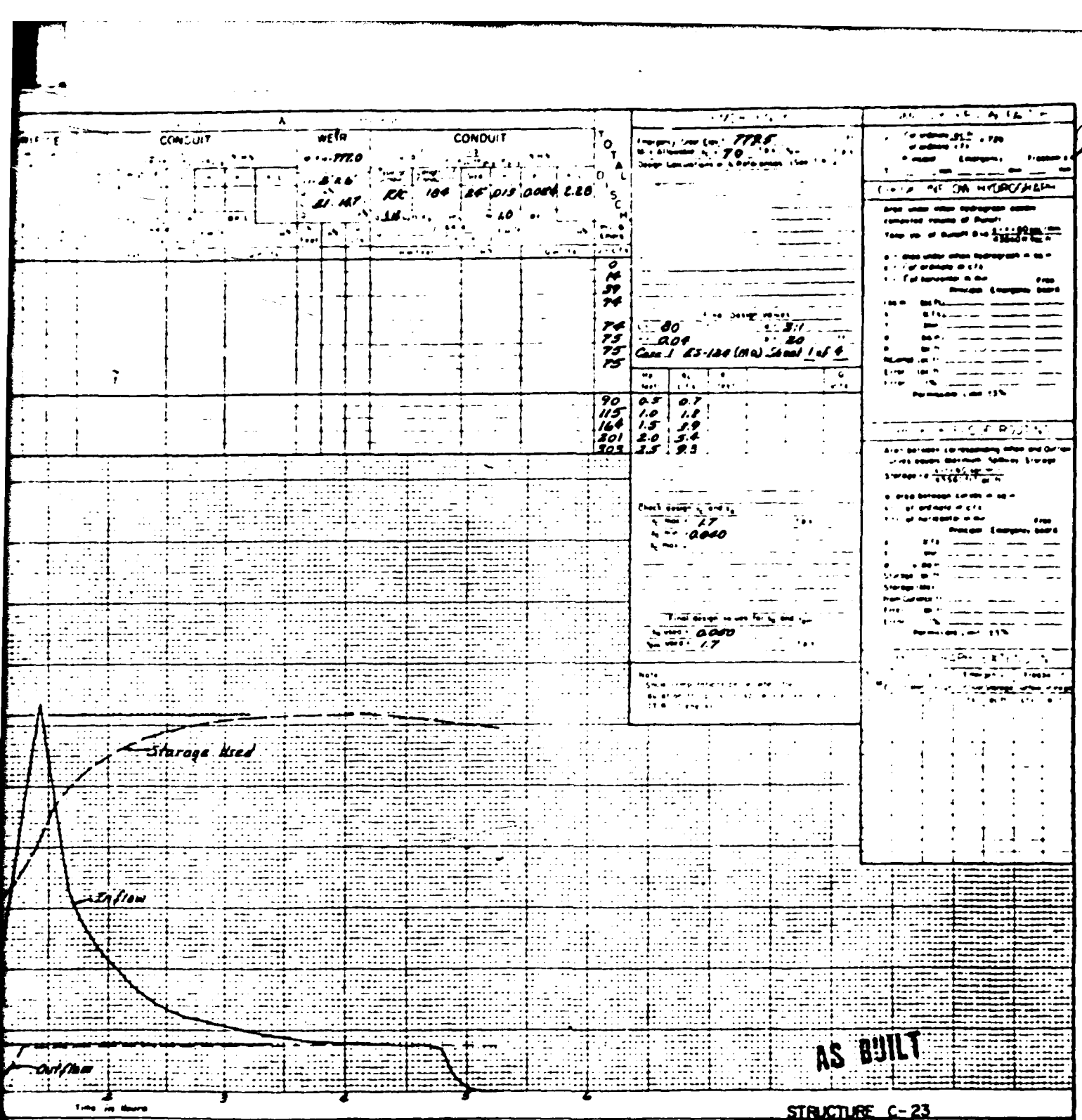
Elev	Area	Storage
777.0	11.8	1497
777.23		1505
777.46		1513
777.70		1562
778.0	12.8	
778.42		1655
778.71		1704
779.14		1754
779.51	14.3	1805
780.01	14.8	1878
780.51		1953
781.01		2030
781.51		2109
782.01	16.4	2190

A: points plotted from computer output data



Inflow Hydrograph Coordinates

0	0
.33	11
.67	27
.91	49
.95	76
1.02	131
1.10	324
1.19	529
1.29	458
1.41	613
1.49	697
1.52	720
1.67	755
1.70	723
1.91	232
2.03	208
2.15	184
2.39	146
2.62	129
2.86	113
2.91	111
3.10	103
3.34	92
3.58	86
3.82	81
4.19	78
4.30	76
4.54	74



AS BUILT

STRUCTURE C-23

FLOOD ROUTING

EMERGENCY SPILLWAY HYDROGRAPH

WELLINGTON-NAPOLEON WATERSHED PL-566

LAFAYETTE COUNTY, MISSOURI

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

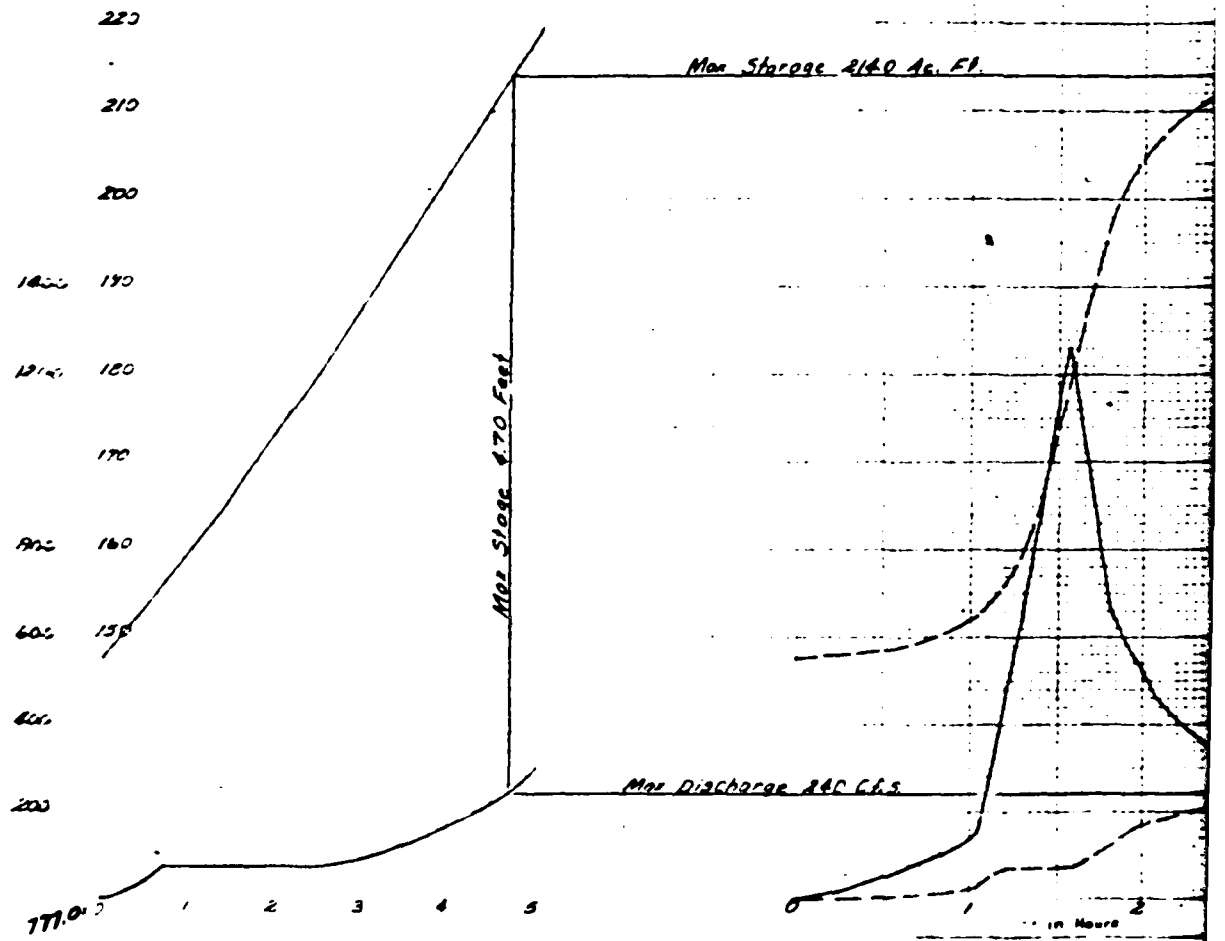
Inflow Hydrograph Coordinates

SUMMARY DATA

SHEET 10 APPENDIX B

See note sheet 1 of 3

For Watershed, Storage and Disc



						0	0	1.58	1221
						.26	21	1.66	1027
						.32	59	1.78	764
						.38	96	1.82	665
						.83	107	1.97	530
						1.04	150	2.08	440
						1.11	279	2.34	365
						1.21	486	2.61	284
						1.30	652	2.87	246
						1.32	702	2.94	240
						1.40	887	3.13	225
						1.47	1041	3.39	203
						1.52	1177	3.65	182
						1.56	1266	3.91	171

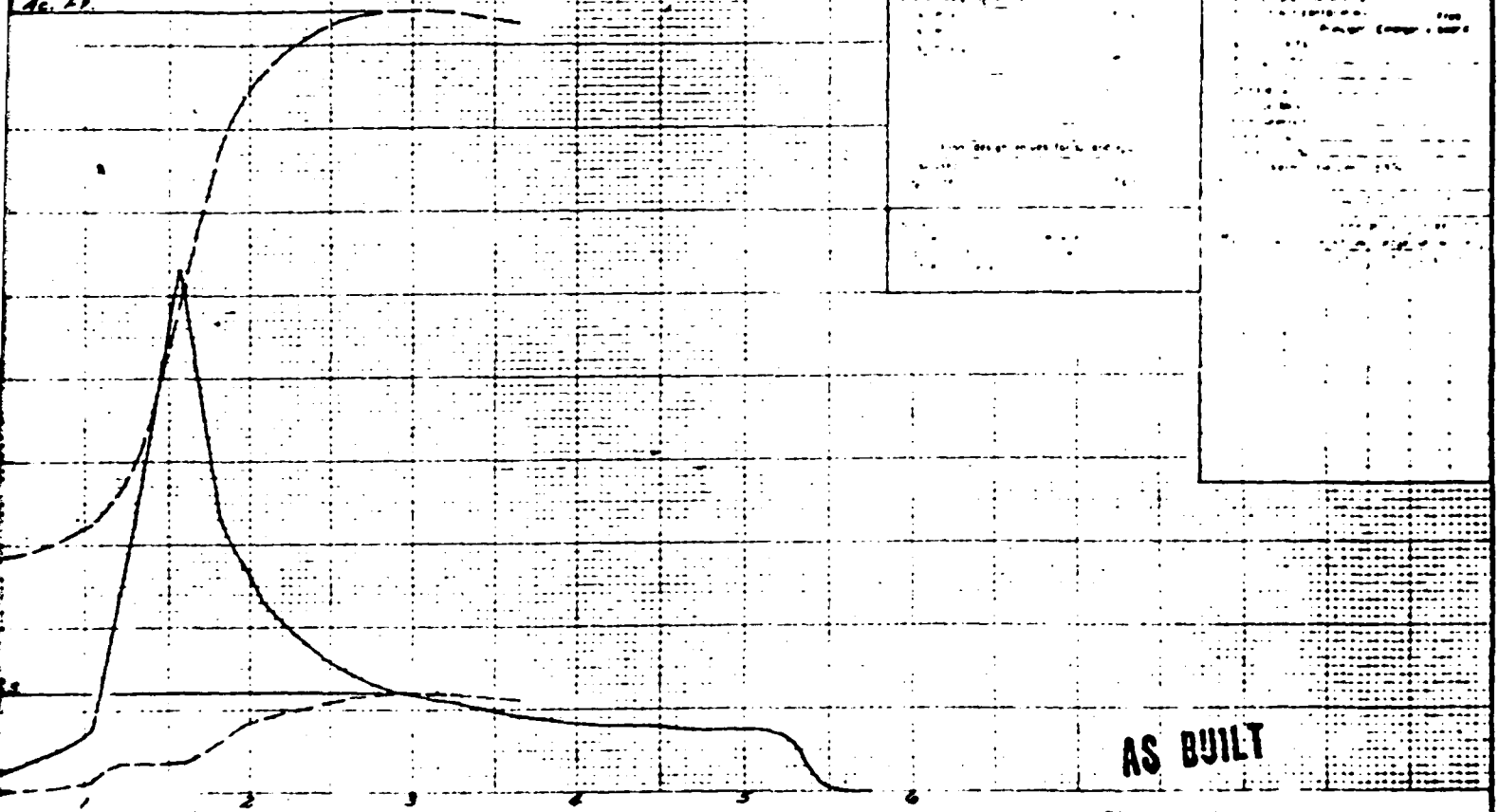
CONDUIT

WEIR

CONDUIT

...shed, Storage and Discharge Data. See Sheet 1 of 9.

Ac. Ft.



AS BUILT

1.58	1221	4.17	160
1.66	1027	4.43	160
1.78	764	4.69	130
1.82	665	4.93	150
1.97	550	5.23	139
2.08	440	5.42	11
2.36	305	5.64	4
2.61	254	5.74	0
2.87	246		
2.98	240		
3.13	225		
3.39	209		
3.65	182		
3.91	121		

STRUCTURE C-23

FLOOD ROUTING

FREEBOARD HYDROGRAPH

WELLINGTON-NAPOLEON WATERSHED PL-566

LAFAYETTE COUNTY, MISSOURI

U. S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

SHEET 11 APPENDIX B

STRUCTURE DATA

		23
		2.30
	ACRES	
	ACRES	1.1
	ACRE	1
PRIN EMER FREEBOARD	C F S	
PRIN EMER FREEBOARD	C F S	17
PRIN EMER FREEBOARD	C F S	
	C F S	
		2
		9
PRIN EMER FREEBOARD		2.60 2.10
		1477
	YEARS	
	PERCENT	
	ACRES	11.8

CHANNEL HYDRAULIC

HEIGHT FROM A FLOOD DETENTION TYPE OF STRUCTURE

STRUCTURE DATA

STRUCTURE	SITE NUMBER			C-23
INFLOW HYDROGRAPH DESIGN DATA	TIME OF CONCENTRATION		HOURS	0.16
	RUNOFF CURVE NUMBER			70
	MOISTURE CONDITION			II
	STORM DISTRIBUTION CURVE			B
	HYDROGRAPH FAMILY	PRIN		3
		EMER		3
		FREEBOARD		3
	Tc/Tp USED	PRIN		36
		EMER		30
		FREEBOARD		30
	STORM DURATION	PRIN	HOURS	6
	POINT RAINFALL	PRIN	INCHES	5.18
		EMER		8.25
		FREEBOARD		14.21
	RUNOFF Q	PRIN	INCHES	2.17
		EMER		4.68
		FREEBOARD		10.11
	STORM FREQ PRIN SPILLWAY		YEARS	50
EMERGENCY SPILLWAY DATA	H_p MAX		FEET	0.1
	Qc		CFS/FT	0.15
	Vc MAX		FT/SEC	1.7
	Sc MIN		FT/FT	0.04
	PERMISSIBLE Vc MAX		FT/SEC	9.1
	Se MAX		FT/FT	—
	Ve MAX		FT/SEC	1.7
STRUCTURE	DRAWDOWN TIME		HOURS	62
	HEIGHT x STORAGE			8393
	CLASS			b

CHANNEL HYDRAULICS

STRUCTURE

AS BUILT

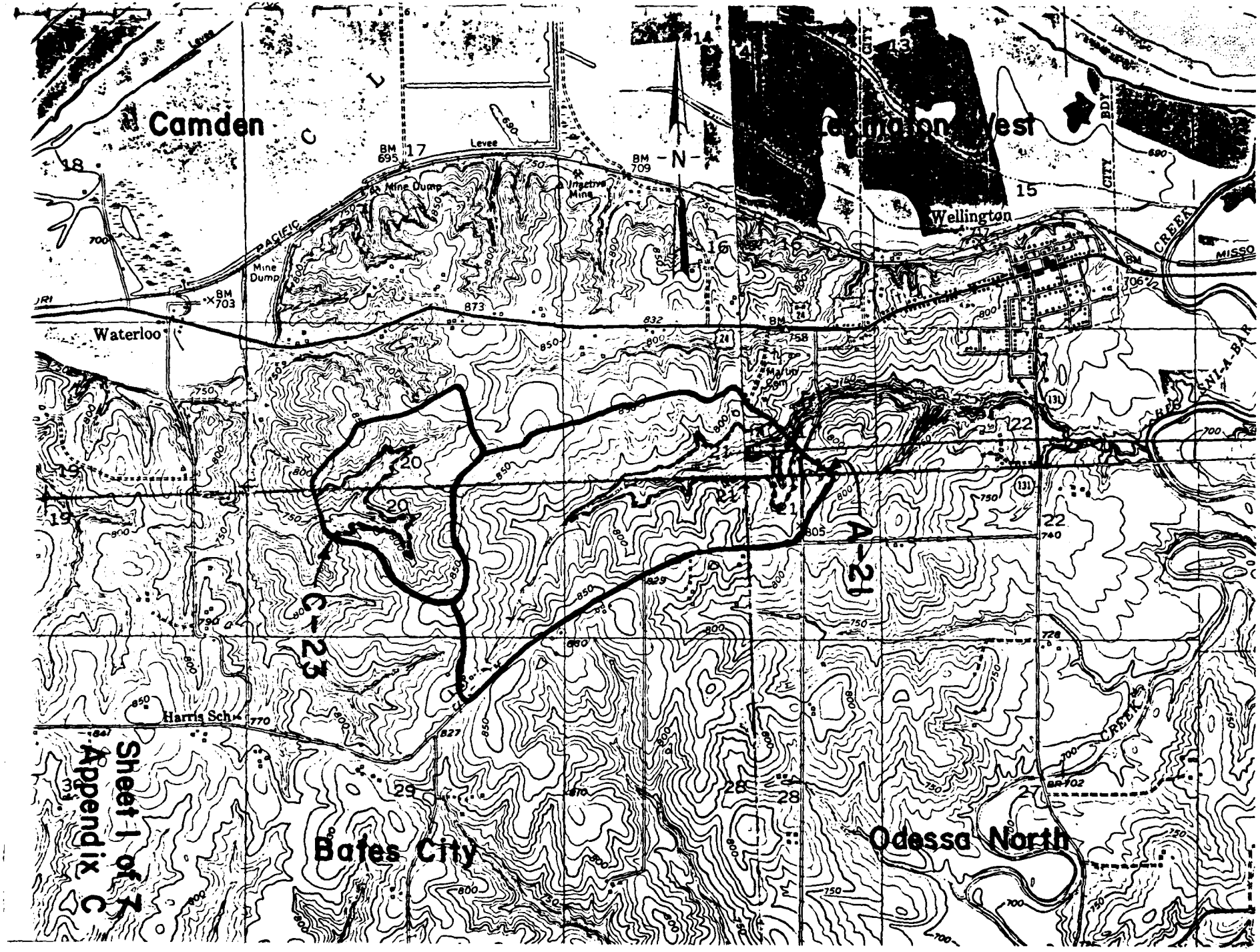
GENERAL DESIGN DATA
STRUCTURE C-23
WELLINGTON-NAPOLEON WATERSHED P.L. 566
LAFAYETTE COUNTY, MISSOURI

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

[illegible]	4/66	
R. E. Smith	10/66	
Ronald B. Randall	11/66	ES-26170-N

SHEET 12 APPENDIX B

APPENDIX C


Camden
Wellington
Waterloo
Bates City
Odessa North
Harris Sch
Mine Dump
Levee
PACIFIC
CITY BDY
SNI-A-BAR
CREEK
MISSO
A-24
C-23
Sheet 1 of 7
Appendix C

HYDRAULIC AND HYDROLOGIC DATA

DESIGN DATA: From As Built Plans and Field Measurements

EXPERIENCE DATA: No records are available. The owner stated that to his knowledge the lake has never filled. The apparent high water mark is at elevation 766, which is 10.3 ft below the primary spillway crest of 776.3 ft.

VISUAL INSPECTION: At the time of inspection, the pool elevation was 761.7, which is about 14.6 ft below the primary spillway crest.

OVERTOPPING POTENTIAL: Flood routings were performed to determine the overtopping potential. Since the dam is of intermediate size with a high hazard rating, a Spillway Design Storm of 100 percent of the PMF was prescribed by the guidelines. The Probable Maximum Flood (PMF) is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. Reservoir area and storage data and the watershed drainage data were obtained from the As-Built plans. A 5 minute interval unit graph was developed for this watershed area which resulted in a peak inflow of 745 c.f.s. and a time to peak of 10 minutes. Application of the probable maximum precipitation minus losses resulted in a flood hydrograph peak inflow of 3202 c.f.s. (see Sheet 5 of 7). Rainfall distribution for the 24 hour storm was according to EM 1110-2-1411. Considering all factors, the combination of dam, spillway and storage is not sufficient to pass the PMF without overtopping. The embankment crest (El. 782.8) would be overtopped by 1.17 ft at flood pool elevation 783.97.

Fifty percent of the PMF was routed through the spillways. The resultant maximum pool elevation was 782.68, 0.12 ft below the low elevation of the dam (782.8 ft). The peak outflow was 319 c.f.s. The portion of the PMF that will just reach the top of the dam at elevation 782.8 ft is about 0.54. The existing spillway system will be able to pass the 100 year frequency flood without overtopping. For additional data see Summary of Dam Safety Analysis Sheets 3 and 4 of this Appendix.

OVERTOPPING ANALYSIS FOR Dam C-23

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
Hydraulic Inputs Are As Follows:

   a. Twenty-four Hour Rainfall of 25 Inches For 200 Square Miles - All Season Envelope

   b. Drainage Area = 146 Acres; = .23 Sq. Miles

   c. Travel Time of Runoff .16 Hrs.; Lag Time 0.1 Hrs.

   d. Soil Conservation Service Runoff Curve No. 85 (AMC III)

   e. Proportion of Drainage Basin Impervious 0.08

2. Spillways

   a. Primary Spillway: Drop Inlet Concrete Structure (Crest El. 776.3) with 24 in. diameter RCP Pipe

   b. Emergency Spillway: Trapezoidal Cut-seeded (Crest El. 779.6)
   Length 20 Ft.; Side Slopes 3:1; C = 2.65

   c. Dam Overflow

      Length 500 Ft.; Side Slopes vertical; C = 3.0

   Note: Combined Spillway and Dam Rating Curve Computed by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards.

SUMMARY OF DAM SAFETY ANALYSIS

L. Unit Hydrograph

   a. Peak - 745 c.f.s.

   b. Time to Peak 10 Min.

2. Flood Routings Were Computed by the Modified Puls Method

   a. Peak Inflow (see Sheet 5)

      50% PMF 1601 c.f.s.; 100% PMF 3202 c.f.s.

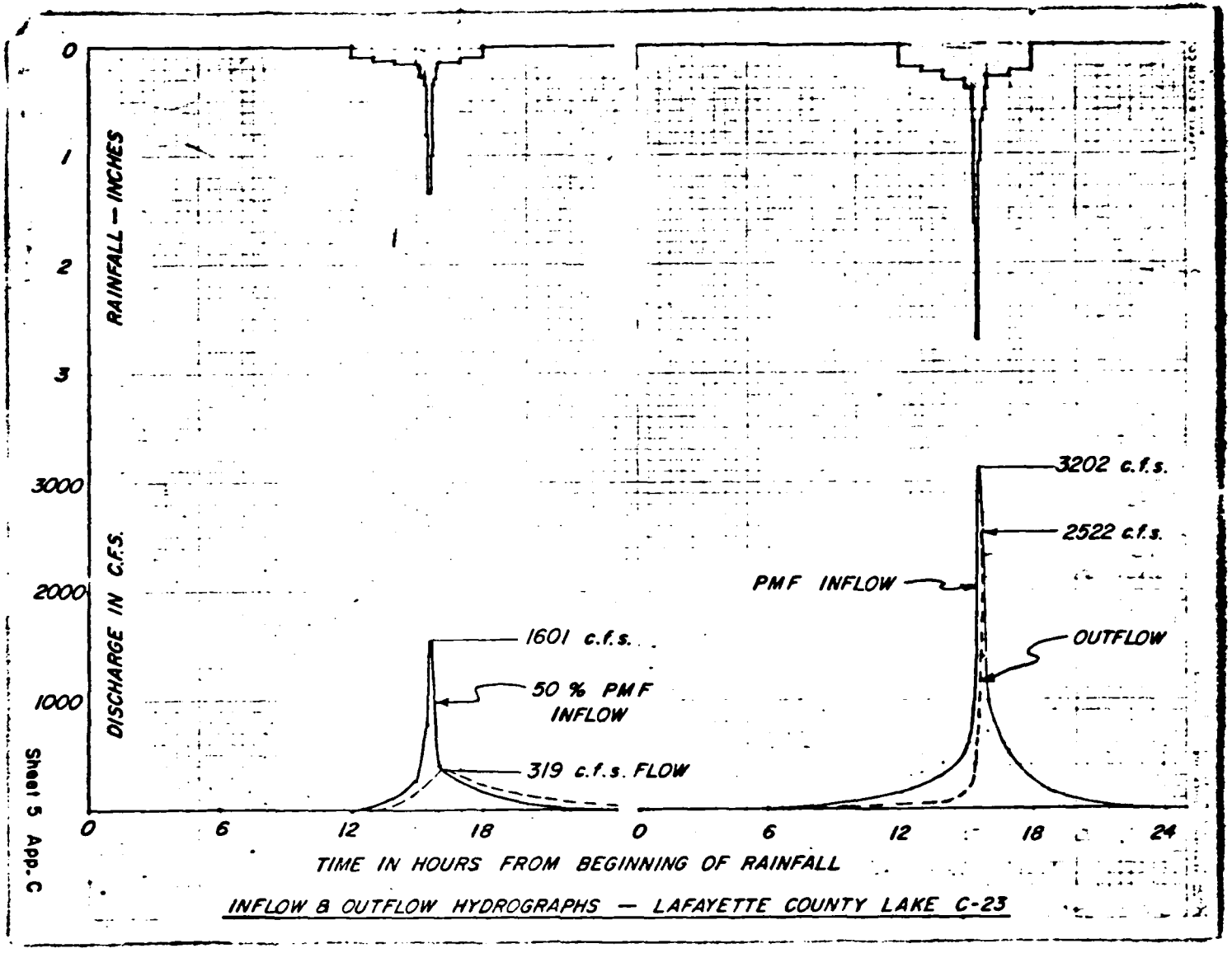
   b. Maximum Reservoir Elevation

      50% PMF 782.68; 100% PMF 783.97 c.f.s.

   c. Portion of PMF That Will Reach Top of Dam

      54%; Top of Dam Elev. 782.8 Ft.

3. Computer Input and Output Data Sheets 6 and 7



INFLOW & OUTFLOW HYDROGRAPHS — LAFAYETTE COUNTY LAKE C-23

Sheet 5 App-C

LAFAYETTE CO DAM C-23 PROBABLE MAXIMUM FLOOD (INPUT DATA)

```
A   ***** OVERTOPPING ANALYSIS FOR LAFAYETTE CO  DAM C-23  (HEC-1)DAM SAFETY
A   ***** CO CODE: 107  CO.NAME LAFAYETTE  STATE ID NO 10263  OWR. OWNER AND D
A   ***** HANSON ENGINEERS INC. DAM SAFETY INSPECTION (JOB NO  03778) *******
B     300        0        5        0        0        0        0        0        4
B1      5
J       1        8        1
J1    0.2     0.30     0.40     0.50     0.60     0.70     0.80     1.00
K       0        1                                   3        1
K1  ***** INFLOW HYDROGRAPH COMPUTATION *****
M       1        2     0.23              0.23     1.00                          1
P             25.0      102      120      130
T                                                          -1      -85
W2   0.16      .10
X     0.0     -.10      2.0
K       1      023                                   0        1
K1  ***** RESERVOIR ROUTING BY MODIFIED PULS *****
Y                                1
Y1      1                                                           -1
Y4  776.3      778      779      780               782.5      783      784      785
Y5      0       74       75       98      [illegible]      327      500     2580     5821
$S      0      143      160      174      188      203      219      235      252
$E    738      777      778      779      780      781      782      783      784
$$  776.3
$D  782.8
K      99
```

0001

2

INPUT DATA

DAM C-23 (HEC-1)DAM SAFETY PROGRAM
E ID NO 10263 OWR. OWER AND DERNA BORGMAN*****
ECTION (NID NO 03778) **********
0 0 0 4 0

.70 0.80 1.00
3 1

.00 1

-1 -85 .08

****

-1
784 785
32 2580 5821
203 219 235 252 268
781 782 783 784 785

Sheet 6 Appendix C

********** ********** ********** ***

LAFAYETTE CO DAM C-23 PROBABLE MAXIMUM FLOOD (OUTPUT DATA)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS
AREA IN SQUARE MILES (SQUARE KILOMETE

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIOS APPLIED T RATIO 3	RATIO
				0.20	0.30	0.40	0.
HYDROGRAPH AT	1	0.23	1	640.	961.	1281.	160
		(0.60)		(18.13)(	27.20)(	36.27)(	45.3
ROUTED TO	23	0.23	1	81	148.	239.	31
		(0.60)		(2.30)(	4.18)(	6.76)(	9.0

1 SUMMARY OF DAM SAFETY ANAL

PLAN 1

	INITIAL VALUE	SPILLWAY CRES
ELEVATION	7[illegible] 00	776.30
STORAGE	143.	145
OUTFLOW	30	0

RATIO OF PMF	MAXIMUM WATER SURFACE ELEV	MAXIMUM STORAGE OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS
0.20	779.27	0.06	178.	81
0.30	780.51	0.09	196.	148.
0.40	781.53	0.11	212.	239.
0.50	782.47	0.00	230.	319
0.60	783.18	0.38	238.	873.
0.70	783.46	0.66	243.	1453.
0.80	783.72	0.92	247.	1990.
1.00	783.97	1.17	252.	2522.

0001

2

(OUTPUT DATA)

(IOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
C FEET PER SECOND (CUBIC METERS PER SECOND)
N SQUARE MILES (SQUARE KILOMETERS)

RATIOS APPLIED TO FLOWS

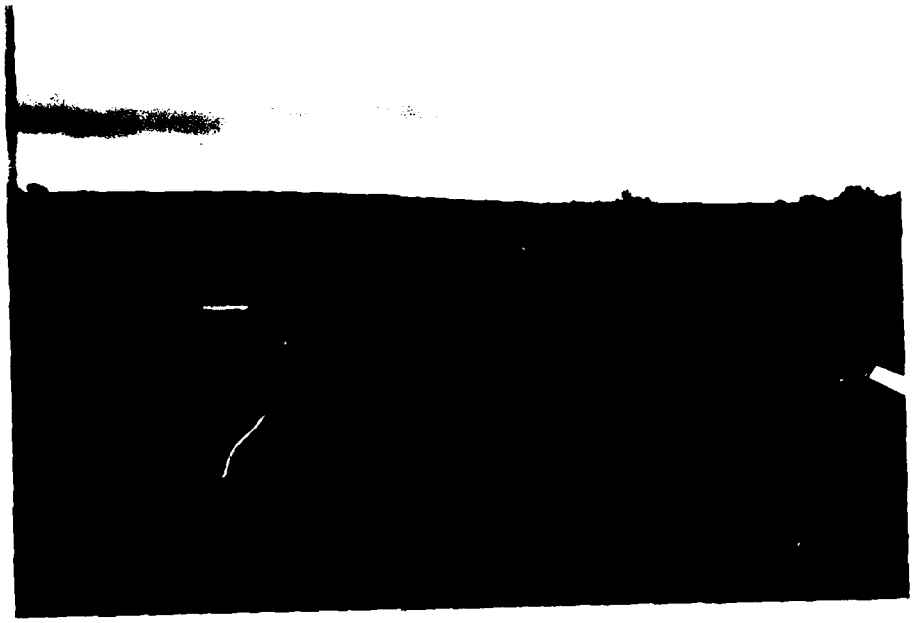
1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8
.20	0.30	0.40	0.50	0.60	0.70	0.80	1.00
40.	961.	1281.	1601.	1921.	2241.	2562.	3202.
13)(	27.20)(	36.27)(	45.34)(	54.40)(	63.47)(	72.54)(	90.67)
81	148.	239.	319	873	1453.	1990.	2522.
30)(	4.18)(	6.76)(	9.02)(	24.73)(	41.14)(	56.36)(	71.41)

SUMMARY OF DAM SAFETY ANALYSIS

INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
777.00	776.30	782.80
148.	145	232.
30	0	327.

RATIO OF PMF OR STORM	MAXIMUM STORAGE VOLUME	MAXIMUM OUTFLOW	DURATION OVER TOP	TIME OF MAX OUTFLOW	TIME OF FAILURE
TOP DAM	AC-FT	CFS	HOURS	HOURS	HOURS
0.00	178.	81	0.00	18.00	0.00
0.22	196.	148.	0.00	17.08	0.00
0.44	212.	239.	0.00	16.17	0.00
0.00	230.	319	0.00	16.17	0.00
0.39	238.	873.	1.08	15.83	0.00
0.66	243.	1453	1.75	15.75	0.00
0.92	247.	1990.	2.50	15.75	0.00
1.17	252.	2522.	3.17	15.67	0.00

APPENDIX D



Top of Dam Along Axis - From North Abutment

Primary Spillway Outlet - Looking Downstream

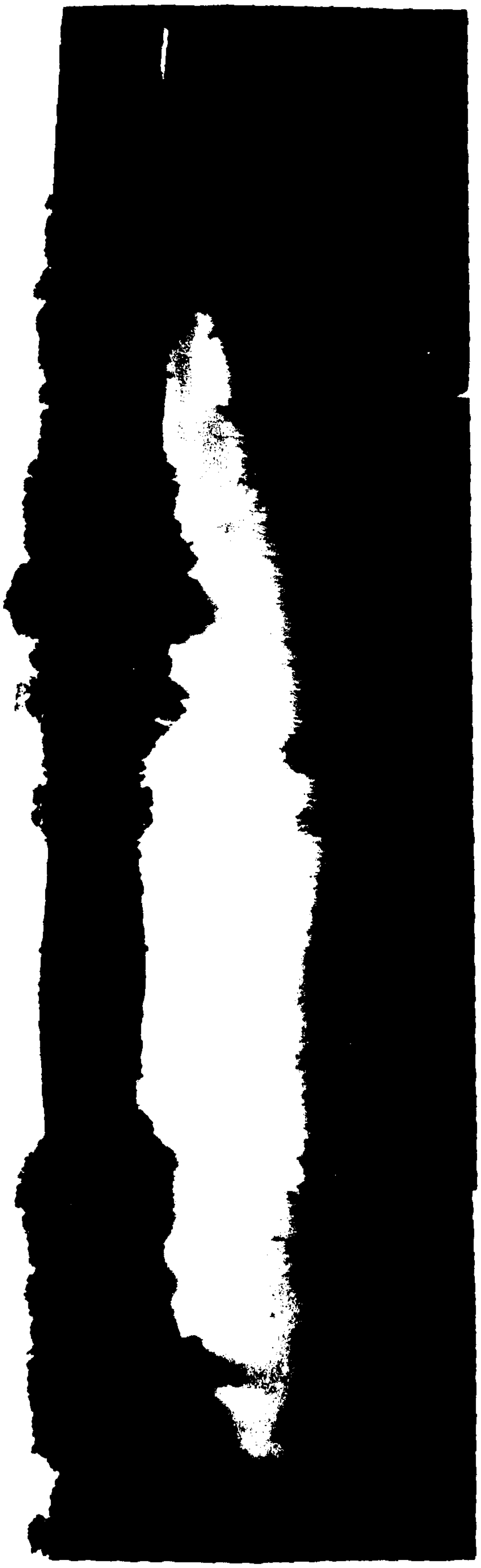
Primary Spillway Outlet - Looking Upstream Toward North Abutment

Sheet 2 of 5

Appendix D

Primary Spillway Outlet - Looking Toward North Abutment

Primary Spillway Outlet - Looking Toward South Abutment



Lake and Watershed - Looking Upstream

Sheet 5 of 5

Appendix D